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THE CONDOR

VOLUME 55 SEPTEMBER-OCTOBER, 1953 NUMBER 5

THE ATTRACTION OF PURPLE MARTINS TO AN URBAN LOCATION IN WESTERN OREGON

By STANLEY M. RICHMOND

The Purple Martin (*Progne subis*) has been decreasing in numbers for many years and has practically disappeared from some sections of the North American continent where it formerly was an abundant summer resident, utilizing man-made nesting sites. Wherever the Purple Martin has nested on farms or in urban localities, it has been appreciated because of its many interesting and valuable qualities.

A recent regional report (Griscom, 1952:274) gives welcome news of the re-establishment of two Purple Martin colonies in Massachusetts, the first in the state since a disastrous, prolonged cold spell wiped out the martins early in the spring, half a century ago (Forbush, 1903).

"Often difficult to lure to a nesting box. Its presence justifies the effort." These views of William Vogt, entered in the caption under plate 22, The Purple Martin, in Audubon's "The Birds of America," may be taken as the theme of the project carried on in the southern Willamette Valley in Oregon during the past five years. Starting in 1948, the writer began to consider by what means the Purple Martin could be induced to nest in bird boxes at an urban location in western North America. The city of Eugene is at the southern end of the Willamette valley in west-central Oregon, about fifty miles from the Pacific coast and an equal distance from the Cascade mountain range. Gullion (1951) has adequately described the climatic and topographical features of the region.

The urban location is a residence plot on flat terrain, facing a busy cross street near the edge of Eugene. The rear of the property is adjacent to a one-acre expanse of gravel parking space utilized by school busses; adjoining this is an undeveloped city park area of several hundred acres drained by a sluggish creek which comes from nearby foothills. There are few trees in the immediate vicinity but a number of insulated telephone and electric wires extend across both the rear and front of the lot between the crossarms of large telephone poles.

Seven species of swallow, including the Purple Martin, are summer residents in the region, but the Purple Martin occurs in small numbers relative to the others. It nests so remotely and flies at such heights that it is absent as far as the general public is concerned and rare or uncommon in the experience of the majority of those interested in birds. To one who has formerly spent pleasant hours watching and listening to Purple Martins in his yard, the martin's status in the west seems unfortunate, for the species represents an undeveloped avian resource which would likely respond favorably to active human assistance such as the erection of suitable nesting sites and action taken against its enemies and competitors.

ESTABLISHED COLONIES

In the major portion of the continent east of the Rocky Mountains, the Purple Martin is a dooryard bird, nesting almost exclusively in houses erected by man, and the observation of a wild nesting site is so uncommon that it merits a published field note. In the west coast states, the reverse is true. At the present time, as far as I can ascer-

tain, the only house colonies of Purple Martins in Oregon are those occupying bird houses on the Southern Pacific railroad drawbridges near the mouths of the Umpqua and Siuslaw rivers. In coastal cities of both Washington and California, Purple Martins nest on business buildings and around other structures. Doubtless, house colonies exist at scattered points in these two states, especially in California, but most reports of Purple Martins' utilizing bird boxes in areas west of the Rocky Mountains were made ten or more years ago.

For the past nine years, martins have been returning to the Umpqua River drawbridge. The bird houses they occupy thereon are under the eaves of the small yellow house containing the drawbridge machinery, high over the water atop the center of the bridge. There is great noise and vibration when the heavy engine is operating to revolve the center span 90 degrees as river traffic approaches. These gyrations, that occur from ten to fifteen times daily, as well as the passing of numerous steam and Diesel trains directly under the martin houses apparently disturb the martins but little. Except for incubating females, the birds fly out and circle nearby during the disturbances.

The bridge-control men first put up small houses for swallows about ten years ago. These were constructed of unpainted plywood and soon began to disintegrate. The original 1½-inch opening in one of the boxes became enlarged, and in 1944 a pair of Purple Martins took the box. Other crude boxes with larger openings were then put up, and, although the largest of these was only 5×5×6 inches, some successful nesting took place in the next few years according to the bridge tenders. Before the return of the martins in 1952, the old houses were taken down and new, weather-resistant houses totaling 17 apartments were installed under the eaves. The old houses were found to be leaky and filled with a ten years' accumulation of damp debris; mites and lice were abundant under the nesting material. Dead nestlings and adult birds as well as old eggs were noted. One triple-unit house had a nest of an English Sparrow (*Passer domesticus*) in one end and a martin nest in the other; a group of small bumblebees flew in and out of the middle unit. These boxes had been placed well back against the building under a widely overhanging eave and bore no resemblance to the traditional martin house on a pole; in fact they were little more than holes in part of the building. The new units, painted yellow, were 7×8×8 inches with 2¼-inch doorways within one inch of the floor. Six of the new units were utilized by martins in 1952, including two apartments on the west side of the bridge, where no houses had been previously. These two faced the direction of prevailing, stormy winds from the ocean.

The second artificially established colony of Purple Martins in Oregon is on a similar drawbridge over the Siuslaw River, 15 miles north of the Umpqua. Six adequate units were placed on this bridge powerhouse, 60 feet above the river, in the spring of 1952, and three of the units were shortly occupied by martins. This establishment was an unexpected success and may indicate a shortage of wild nesting sites as well as a preference for nesting in colonies. In Connecticut, where the paucity of Purple Martins is lamented by those interested in birds, an unsuccessful attempt has been made over a seventeen year period to spread a colony to other nearby boxes placed from one-half to fifteen miles away from the still existing colony at Westport. Apparently, the population in this colony is dwindling, according to Michael Oboiko, the sponsor of the colony.

WILD NESTING SITES

In the West, the Purple Martin is perhaps most often noted by former residents of the eastern, midwestern, or southern United States. On a quiet day, the high-flying martin's song may be heard at a great distance and for this reason one familiar with this species often knows the martin is overhead, even though he cannot locate it. Gabriel-

son and Jewett (1940) said, "We consider the beautiful and companionable purple martin a decidedly uncommon bird in Oregon." But Gullion (1951) later listed this species as a common summer resident while Mr. Ben Pruitt has seen and heard martins high over the southern Willamette Valley almost daily in summer. He first noticed them ten years ago and found a nesting site in 1945.

In 1950, after considerable search, Pruitt and I found numbers of martins feeding and perching about an urban location on the fringe of the Eugene-Springfield area, and we later ascertained that most of these birds took off each evening up Camp Creek canyon in the direction of Mount Nebo, one of the higher foothills (2500 feet) of the Cascade Range, twenty miles northeast of the spot where they perched each afternoon. A few martins were observed homing in other directions into the surrounding foothills. At one time, Pruitt counted sixty of these martins perching on the high, dead tree they frequented. One summer passed with numerous field trips made in an unsuccessful effort to locate nests of these birds.

In the second year of search I finally located a number of nesting sites near the top of Mount Nebo at about 2000 feet elevation. On a flat promontory of several acres, in a burned-over area, there were close groups of magnificent, gray, coniferous snags almost devoid of limbs and from 150 to 200 feet in height. Thirteen holes were noted high in the tops or sides of the snags by watching martins enter and leave. The spot had a commanding view of many miles, and it was interesting to note that from here the perching and feeding area in the urban district where Purple Martins were originally found could be identified through binoculars.

Because the most valuable resource of the Northwest is timber, the prevention and control of fire in the forests is of foremost importance; it is unfortunate for hole-nesting species that on Oregon's 9,987,000 acres of privately owned forests, the major lumber interests have embarked on an intensive program of systematically felling snags and dead trees which, due to their height, are frequently struck, splintered, and ignited by lightning. The fire-control crews have a special dislike for tall snags since fire may quickly go out of reach to the tops and be scattered beyond control lines by the wind. On the 15,251,000 federally owned or managed acres, the Forest Service rules require the felling of all snags within and for an additional 200 feet about all logging areas. The state also has regulations regarding the felling of snags on 1,101,000 acres of state-owned timber, according to Ross (1950).

The huge snags in the Mount Nebo location, supporting what appeared to be the major Purple Martin colony for this part of the county, were all torn down in the winter of 1951, as was the favorite perching tree 20 miles away, in the valley, on the edge of town. I have been unable to find any new loafing site where the birds perch in the afternoon, but I assume that in the mountains the martins have taken over other snags for nesting. It should be kept in mind, however, that these relatively soft-beaked birds require a special type of snag—one that has been extensively processed by woodpeckers. For such a snag there will be considerable competition.

Another factor that will no doubt affect the welfare of the Purple Martin in its primitive nesting sites is the campaign currently waged against the spruce budworm (*Choristoneura fumiferana*) in this region. The especially deleterious DDT–oil mixture is sprayed by plane over certain infested areas designated by field men or airborne spotters. One pound of DDT to a gallon of fuel oil with one pint of hydrocarbon solvent added is used in a concentration of one gallon of spray to the acre. A half million acres are scheduled to be sprayed in the spring of 1953; some three and a half million acres already have been sprayed in the present three-year program. In 1952 the spraying of DDT took place in May. The Douglas fir beetle (*Dendroctonus pseudotsuga*) started

an alarming epidemic of infested, living trees in the fir forests of western Oregon in 1950 and is now receiving specific attention. The only known way to combat this pest is to clear forests of windfalls, fire-scorched trees and infested timber as soon as possible. These clean-up programs will no doubt materially reduce the number of old snags in the forests of the West, for loggers in many instances are laying aside their normal logging plans in order to salvage merchantable windfalls, infested timber, and fire-scorched trees; even the very old, dead snags often contain considerable sound lumber.

The data from Ross (1950) indicate the extent of Oregon's forests wherein a perpetual supply of dead trees might be expected but for the clean-up program. The pests will receive increasing attention, for today insects and disease destroy more trees than fire. Officials of the Willamette National Forest are cooperating in a new project to erect boxes of simple construction in the forest to replace the destroyed homes of hole-nesting species and possibly to augment the swallow populations. Imagos of both the spruce budworm and the Douglas fir beetle fly about during the mid-summer when swallows are most active.

In the coastal area adjacent to the Umpqua and Siuslaw rivers, a number of wild nesting sites have been found in old pilings used in log-rafting operations on the coastal streams and lakes. Apparently the Purple Martin is more abundant here than in the Willamette Valley, for many inland residents reported having seen martins only along the coast. The Oregon coast is heavily forested, but the martins seem to prefer old piling well surrounded by water. Most of these tree trunks protrude less than ten feet above the water. One nest was found at only five feet above the lake level, which is within ten feet of sea level. This finding, considered with Huey's (1936:125) report of Purple Martins nesting in Arizona at an elevation of 8600 feet, further indicates that this species must nest wherever it can find suitable sites, even where the general surroundings are not ideal. The scarcity of nesting sites both on the coast of Oregon and inland prevents martins from nesting in colonies as they would no doubt prefer to do. A large number of holes in trees and piling were examined by means of ladders, climbing irons, and the use of boats when necessary. Fully fifty per cent of the openings which appeared to be sites of hole-nesting species when seen from a distance terminated blindly within a few inches or ended in fist-sized cavities where woodpeckers had ceased excavation for one reason or another.

APPARENT NEED FOR CALCIUM

When martins were first found at their perching and feeding areas locally, it was noted that they settled on the ground surprisingly often. They were seen to be searching for and picking up small, light-colored particles most of which they flipped away as they continued walking about. Several areas where I saw martins fly down more than once were inspected. The spots were either dark, top soil in cultivated fields or expanses of grayish, black gravel made from crushed, basaltic rock. The cultivated fields had been fertilized with chicken-house sweepings which coincidentally contained small amounts of crushed oyster shell and a trace of granite grit.

Beal (1918:5), in listing stomach contents of Purple Martins, expressed curiosity when he found the vertebra of a fish and a small piece of mollusk shell. Seibert (1942) reported martins landing and picking up something from light-colored soil on the side of a steep bank in the San Francisco Bay region. Bent (1942:498) reported correspondence with Farley who had seen Purple Martins pulling at oyster shell in stucco buildings. Many martin fanciers have provided egg shell for their colonies.

In Eugene, in 1952, I observed a martin try without success to pull a small white particle from a freshly poured cement column. In July, 1952, I went to a reservoir on

a hill top a mile from my home where I had seen martins flying about and tested their interest in egg shell. The concrete reservoir is covered and the top is a flat expanse of about four acres of cement. Waiting until martins were a short distance overhead, I threw a handful of crushed chicken egg shell upon the reservoir top and backed away 30 yards. The flying birds noticed the shell at once and made passes to look at it closely. Within two minutes, a female alighted and picked up several small pieces and flew away. In the next ten minutes another female and two males came down to the spot to eat and apparently carry away some of the material. A week later, I returned and could not find any of the shell. The well leached, acid soil of western Oregon is low in lime (Powers, Jones, and Ruzek, 1939); also calcium carbonate outcroppings are absent so that calcium salts are seldom available in visible form in the dark, volcanic crust.

Mrs. William Schnorenberg, who resides on a hill top about five miles to the west of Eugene, reported that in the summer of 1950 she marked out the dimensions of a proposed driveway by pouring streaks of slaked lime from a sack. Later in the day she saw large, black swallows come down and take beakfuls of the powder and fly away. They made several trips in the next three days. Mrs. Schnorenberg subsequently located a Purple Martin nesting site in a tall snag on her acreage.

AVAILABILITY OF BIRD BOXES

Apparently the Indians of western North America did not put up artificial nesting sites for birds as did the Indians of the eastern and southern regions. According to Twining (1931:90), the Indians of the West called the martin "the bird that never rests"; so perhaps this bird has always nested in scattered, remote places throughout the West.

Few bird houses seen about Oregon are adequate for martins. The most common inadequacy noted is smallness of the opening; skimpy size and poor location are also repeatedly seen if one notices bird boxes. Many well-built, advantageously placed houses are seen with openings of one inch or even less. Most of the older Oregonians never have known the Purple Martin and the newcomers who are familiar with the bird often do not know it is here; this may be the reason why desirable nesting boxes have not been put up in large numbers with Purple Martins in mind.

Questionnaires were sent out to 100 individuals in western Oregon known to be interested in birds, as indicated by their participation in annual bird counts, compilation of avifaunal lists, and/or active membership in the Oregon Audubon Society. The results of the questionnaire (table 1) indicate that this not uncommon species does not receive the attention it deserves.

Table 1

Frequency and Abundance of Purple Martins as Determined by Questionnaires Received from 86* Observers in Western Oregon

Never observed	Seen once	Seen occasionally	Seen frequently or each summer
45	12	16	13

Abundant	Very common	Common	Uncommon	Rare	Absent
0	0	8	39	37	2

* Thirty-one observers had known martins elsewhere in the United States; 19 of these never saw the species in Oregon. Eleven had erected one or more suitable bird boxes with 2-inch openings. Sixteen had observed nests.

More than forty units of housing for Purple Martins were erected by me within a ten-mile radius of Eugene in the past five years. Ten units have been up for three years and several units for five years. These houses were traditional, white, multiple-unit martin boxes on fifteen- and twenty-foot aluminum poles. Fourteen units were placed

atop an eight-story business building; of these, eight built together in a house, were erected on a tall pole upon the roof, and the others were tucked under the eaves at the top of the building facing an area one mile distant where martins have been repeatedly seen. No one has reported a prospecting martin at any of the boxes on the building or elsewhere. Tree Swallows (*Iridoprocne bicolor*), Violet-green Swallows (*Tachycineta thalassina*), and English Sparrows have taken some of the lower boxes. In suburban areas, two boxes were taken by Western Bluebirds (*Sialia mexicana*) and one by a House Wren (*Troglodytes aëdon*). Each spring there is considerable activity of Tree Swallows around the boxes on the business building at the eighth floor level and above, with half-hearted attempts at nest building. Tree Swallows have nested successfully in boxes on the window sill at third floor level for the past two years, but there has been no successful swallow nesting in the other, fought-over spaces higher up. Only fifty per cent of the 40 units erected in the Eugene area have been utilized.

The Purple Martin in this region apparently has little interest in bird boxes, for even though I have had wild martin visitors about my home frequently in 1951 and 1952, I have seen only one of these visitors ever alight on a bird house and inspect it in spite of the presence of five houses on poles around the back yard. In late July, 1952, a martin came several successive mornings and examined the same double-unit house on a pole. The bird was apparently a year-old male, not banded. The wild birds visited because of the presence of young, hand-raised martins in the back yard. The visitors would usually circle slowly overhead or perch for a few minutes on wires adjacent to the property.

COMPETITION FOR BOXES

The English Sparrow, Western Bluebird, and to a lesser extent the House Wren are important competitors for the swallow boxes. That Tree Swallows may prevent the establishment of a martin colony merits some consideration. Both Tree Swallows and Violet-green Swallows are present in large numbers in western Oregon, and as soon as they arrive in late February and March, they begin to inspect and fight over the available boxes. Thus, when the Purple Martins arrive in mid-April or May the smaller swallows are well situated. Pairs of these less sociable species often choose a multiple-unit house and allow no other swallow to use any of the vacant cells. This is not true of English Sparrows, which may co-occupy such a house with martins. In Tree Swallows, however, even before serious nest building begins, a male will select a house and drive all birds from adjacent houses within 75 feet of his own, especially if the houses are in front of his. In regions where martins are not using houses and where Tree Swallows are abundant, the latter should be considered the principal deterrent to the establishment of Purple Martin colonies. Evidence for this is given in the following paragraphs.

In discussing Purple Martins and their troubles with Tree Swallows in Massachusetts, Bagg and Eliot (1937:392-394) state that "Tree swallows have established large colonies; occupy all available houses before martins come and resent the occasional attempts of their larger cousins to lodge beside them. The mobbing of house-hunting martins by tree swallows is an all too frequent sequel to the hopeful erection of a martin house."

Kuerzi (1941:14) reported that a colony of Tree Swallows he observed would allow four species of swallow to enter into their bounds to feed or gather nesting material; however, the appearance of a Purple Martin caused considerable agitation, and the larger swallow was driven off. Weingartner (see Nichols, 1952:276) noted Tree Swallows take over a martin house and drive the later arriving martins away when they attempted to co-occupy.

Allen (1952:644), *who spent many hours studying Purple Martins, thought that the martin's fighting ability was mostly bluff, because it gave up easily if an opponent persisted. He noted that martins too often fought as individuals rather than as a group and that a male English Sparrow or Tree Swallow often bested a male martin in individual combat.*

In 1952, I observed several Tree Swallows at my colony as they spotted two approaching Purple Martins at a distance of 200 yards. Giving alarm calls, the Tree Swallows charged out to meet the martins and harassed them as they would hawks until the martins turned away. It is felt that a well established martin colony could return and repossess its nesting spaces in most instances, but if a solitary martin, scouting for a location, received such attention as the birds just mentioned, the martin would no doubt lose interest in a new nesting site.

The Tree Swallow has three biologic advantages over the Purple Martin: first, it often produces two sets of young a season; second, it arrives at the nesting site a month earlier; and third, according to Beal (1918:16), the Tree Swallow may utilize as high as 19 per cent vegetable matter in its diet. This vegetarian faculty may be a decisive factor in survival during occasional prolonged cold or rainy spells which are often disastrous to the completely insectivorous martin.

It has been suggested that the problem of house competition at a given location might be solved for the martin by setting up a large number of houses and thus providing space for all birds, but such a step has failed to lure Purple Martins from their nearby snags on the Lyle Dunsmoor estate, near Portland, Oregon. "We have 60 houses at our place, occupied at times 100% by tree swallows, violet-greens, house wrens and blue birds," writes Mr. Dunsmoor. The houses have been provided for the past six years and Tree and Violet-green swallows constitute 75 per cent of the housed birds.

"DOMESTICATION" OF PURPLE MARTINS

The obvious way to cause a martin to return to a nesting box is to cause it to be born and raised in a nesting box. Accordingly, several steps were taken with a view to producing this result. In the first three years of the project, two clutches of four martin eggs were received from Arkansas by air mail and were substituted in accessible boxes under Tree Swallows just starting incubation. The foster parents waited out the extra days required to hatch the larger eggs and each clutch produced two Purple Martins which were then well tended by the Tree Swallows. The first clutch died at two weeks of age when the box became overrun with black mites and the second pair of martins died from heavy infestation with *Apaulina* larvae.

These efforts involving different genera of swallows did not last long enough to reveal some of the problems which the feeding and fledging differences might have produced. The earlier proficiency of young Tree Swallows, which are self-reliant when they first take the air, might have caused some difficulty, inasmuch as martins normally remain in the nest longer and are then fed in or near the nest for several days after they can fly about.

Another attempt to obtain some martins hatched and raised in bird houses involved the erection of bird boxes adjacent to wild nesting sites of Purple Martins, in the hope that the martins might take over a more suitable nesting space after becoming familiar with it. Other bird students in the state were urged to do the same if a nesting site was found. Of the two houses I erected, one of twelve rooms was lost in the snag-felling program and the other was brought down by a bored huntsman with a rifle. The latter house was in place an entire season in which the birds returned and took their hole in the snag a few feet away. The house had not been there when they left the year before, however,

so it was something new to them. Could the house have been spared another season, the young birds that returned might have taken to it since it would have been a natural part of their world. This experiment should be carried further.

A house with a trap-door was put up on one of the coastal Southern Pacific drawbridges in 1951 and later a brood of three, ten-day old Purple Martins and an adult female were trapped at night and the box carefully transported and attached to a pole in my yard within two hours. In an effort to get both parent birds, the box had been made 9×9×10 inches, but in spite of the roomy house, the father took the male swallow's traditional prerogative and roosted out at night.

Next morning, the parent bird flew out and away in ever widening circles when the box was opened. After an hour or two of waiting, the house was taken down and hand feeding of the nestlings was begun. The three birds survived. Their interest in and utilization of a bird house was such that a possible method of establishing a martin colony through the hand raising of birds in boxes became apparent; for, as indicated previously, the greatest impasse met in trying to start a Purple Martin colony in the West is the martin's seeming lack of interest in bird houses. Allen and Nice (1952:652) found that the majority of Purple Martins returned to the exact or general location of their birthplace.

HAND RAISING OF PURPLE MARTINS

Twenty-one martins have been hand raised, 3 in 1951, 10 in 1952, and 7 in 1953. This strenuous work was begun initially when the mother bird deserted the three birds in the relocated box mentioned and was continued the following year with birds hatched from eggs and with nestlings taken from nests when a week or more old. Another trap box was used in the daytime to get both parent birds and three nestlings for another trial at relocating a family of martins. The same result was obtained as before, but the young birds were successfully raised.

Eggs taken from nests may be placed under swallows for incubation or they can be hatched in an incubator. In either case, they were first incubated artificially until transillumination revealed a growing embryo in order that infertile eggs would not be placed under swallows. Martins hatched by swallows were removed for hand feeding when about six days old.

In three years, a few lessons have been learned concerning the handling of eggs. All the eggs were lost during shipping from Arkansas in 1951 when they burst at high altitudes during air transportation. This happened repeatedly to small shipments of three or four carefully packed eggs in spite of various labels and explanatory data attached to shipping containers. Air line officials doubted that their handling had been at fault since they successfully transport fertile chicken eggs without this damage; they added, however, that some breakage difficulties occurred at high altitudes when confections such as candied cherries were shipped by air.

After losses in two successive years from this cause we now know that the best way to ship small birds' eggs is by parcel post, special delivery, wherein they must be separately packed in cotton or individual sponge rubber capsules and enclosed in a strong, rigid shipping container. The rail shipment takes only a day or two longer from Arkansas to the west coast and has given better results than by plane, although the eggs would no doubt be safe in the air if carried in pressurized passenger compartments.

The dozen eggs received from the east by Parcel Post in 1952 were placed directly into an incubator upon arrival and eight of them developed. Two of these were later placed under a setting Tree Swallow where one hatched. Of the remaining six, three were hatched in the small incubator containing an electrical heating unit, a thermostat, two small fans, a water pan, and hygrometer.

Unless one has nothing else to do, or has considerable help that is reliable, he should not attempt to hatch and raise insectivorous birds. In the case of Purple Martins, even if one uses a related species such as the Tree Swallow to incubate and feed the tiny nestling until it is a week old, the young bird requires hand feeding for yet another four weeks.

For incubator hatching, the martin eggs were placed on cotton in the incubator tray and kept at a temperature of 101°F. for one day; they were then held at near 100°F. for several days after which the temperature was gradually lowered to around 98°F. The eggs were gently turned with the eraser end of a pencil every twelve hours. The humidity was kept near 70 per cent until within two or three days of hatching when 80 per cent or above was sought in order to soften the shell. The artificially incubated eggs hatch in 17 or 17½ days.

In one clutch of three eggs, each bird made the initial peep hole within two hours of the others, and the birds could be seen struggling within the shell. After two or three hours, one of the three was helped out by means of some delicate picking instruments. It was thought that this interference was unnecessary, so the other two eggs went on into the night without help. The following morning, the shells were essentially the same; each was then carefully opened. One bird was dead and the other definitely depressed. Only the first of the three birds survived. In retrospect, it is recalled that the shells of these three eggs were unusually tough and glass-like which would indicate deficient moisture in the incubator. Humidity is difficult to regulate in a small incubator. Green leaves are usually found in nests with Purple Martin eggs and it is thought that the leaves furnish necessary moisture for hatching; however, Miller (1935) suggested that the choice of aromatic leaves might indicate a different reason. Byrens (1942) substantiated this suggestion.

As soon as the martins are free from the shell they gape unsteadily for food and some of them give a *cheep* of extremely high pitch and surprising volume. It is most difficult to feed them, for the diameter of the mouth is 5 millimeters or less, and the head sways erratically from side to side so that the mouth is difficult to hit during the brief period of gaping. Anything placed in the back of the pharynx is eagerly swallowed. If a common house fly is rolled in the fingers to break up and streamline the contour, the newly hatched martin can swallow it. Smaller insects of a more fragile type such as lacewings and pieces of mayfly are more easily handled. If not fed, the bird assumes the embryonic position with the head tucked down upon the abdomen and sleeps fitfully for a few minutes after which it will again gape for food. Some slight disturbance such as jarring, fanning a current of air, or giving a high, whistled note will initiate gaping after the bird has slept for a few minutes, providing it is hungry. A combination of the above stimuli works best. Small insects and small forceps are necessary and a useful prop is a slightly opened button-hook which is placed around the neck near the chin to fix the swaying head while poking a small morsel into the pharynx.

During the next five days the incubator was kept at 95°F. but was opened at hourly and later at thirty-minute intervals for feeding. The small bird soon resumes gaping after swallowing the first morsel of food given and will accept two or three small insects or fragments consecutively. The intervals of satisfied sleep become shorter as growth progresses. At the age of six days the young martins were transferred to an indoor bird box with hinged roof and feeding through the entrance hole was started. After observing the direction from which the food comes, the nestlings, within a day or two, begin to gape toward the hole instead of straight overhead; when fourteen days old, they extend their heads from the box in anticipation of food. By the nineteenth day, the birds will come out on the porch when hungry, if enticed with food.

DIET OF HAND-RAISED MARTINS

The procurement of an adequate food supply presents an even more difficult problem than the time required to feed and care for young birds. The food must be fresh and clean since passerines are especially subject to virus and bacterial agents causing rhinitis, bronchitis and pneumonia as well as enteritis. Special care was exercised to prevent contamination of the food and of the birds' mouths, for birds, if not gathering their food under natural circumstances, may quickly acquire an unfavorable intestinal flora (Fox, 1923:418). Material from the oral-respiratory tract of humans is potentially dangerous, and a likely source of infection is children, whose hands are usually contaminated and who are naturally attracted by the birds. The hungry martins will try to swallow a finger that is thrust toward them, and children find this quite intriguing. A small amount of antibiotic powder was added to the daily diet of the birds because of its nutritional effect and to maintain an increased resistance to infection.

The procurement of enough insects to feed ten young martins over a five-week period is a problem to be solved only by means of outside help. Through the cooperation of the county agricultural agent of a neighboring county and accompanied by young helpers, Mr. Pruitt and I harvested twenty-five pints of eastern Oregon grasshoppers on one expedition scheduled shortly before the annual grasshopper poisoning program began. These large hoppers, captured while soft and immature, were quick-frozen in water and kept under refrigeration as a frequently used, auxiliary food supply for the martins.

The birds show a preference for live insects at all times, and it is necessary that these be collected incessantly. Traps were devised to catch earwigs while other insects were gathered from their habitat or purchased from neighborhood youngsters. The following insects have been used repeatedly with no bad effect: crickets, moths, small butterflies, mayflies, dragonflies, lacewings, pill- or sow-bugs, earwigs, spiders of many kinds, cutworms, houseflies, horseflies, bees and wasps, smooth caterpillars, and anterior portions of a few earthworms.

If spiders or insects that can bite or sting are used, the stings should be completely removed and the mandibles crushed before they are given to these soft-beaked, moist-throated birds. Grant (1945) observed that martins and other swallows apparently do not eat worker bees but choose the stingless drones. In the present project, I have been repeatedly convinced that swallows would not eat worker bees voluntarily. The worker bee's sting is so constructed that even after it has been removed it can penetrate any suitable surface coming in contact with it. Hungry juvenal martins would often grab a bee before I could remove the sting and in every case the bird at once began repeatedly to shake its head violently and then would often appear sick or depressed for an hour or two. One bird was evidently stung deep in the esophagus near the level of the syrinx, for in addition to discomfort, there was an immediate voice change that lasted an entire day. On several occasions when a bee had been stepped on or hit with a fly swatter, I could not locate the sting readily in the disorganized specimen; yet even these mashed bees often produced a sting in the gullet. Although many worker bees with stings removed were eagerly eaten during the hand feeding phase, it was repeatedly noticed that juvenal birds, having started daily foraging for food, would reject or even appear frightened when subsequently offered worker bees as food; this indicated that they had tried taking bees while out feeding and had learned a lesson. During its gluttinous phase, the bird that was stung near the syrinx had two other painful experiences with bees and became so afraid of bees that it would fly away if offered one.

One healthy ten-day-old martin became sick immediately and died two hours after being given half a large, hairy, black and yellow caterpillar (species undetermined).

However, on several occasions the pale green, horned caterpillar of the monarch butterfly was cut up and used as food without the birds' showing evidence of distaste or illness. This instance of mortality was the only one occurring in Purple Martins over three days old in the course of the hand feeding in 1951 and 1952. The unfortunate nestling was one of the incubator-hatched martins from an Arkansas egg. It showed signs of distress at once after swallowing the piece of hairy caterpillar, regurgitated it with difficulty and then appeared depressed. During the next hour there was some edema of the eyes with a watery, mucoid discharge from the eyes, mouth and nares. Respirations became slow and labored preceding death. The esophagus contained many of the spiny, black hairs that were apparently lightly penetrating the mucosa.

Since live insects are often difficult to obtain, one casts about for suitable substitute or accessory foods with which to pad the diet of insectivorous birds. Because protein is the essential diet requirement for growth, it would appear that lean meat and boiled egg would be acceptable. Both of these have been used regularly; however, careful selection of fresh, lean meat rather than hamburger or other conglomerations is advisable. Small amounts of fresh liver are excellent as occasional additions to the diet.

The Purple Martin's gastrointestinal tract must need a certain amount of roughage as furnished by the exoskeletons of insects, for when such non-residue foods as lean meat and egg are given in even moderate amount, a diarrhea develops which would no doubt soon lead to serious intestinal and metabolic changes. Each juvenal martin can ingest about one cubic inch of meat or egg daily, in divided portions, without such difficulties. The martins greatly enjoyed pulverized, hard-boiled egg containing some antibiotic powder and a small amount of the common vitamins, calcium and iron salts and other nutritional factors in powdered form as they occur in a capsule (Natabec,® Parke-Davis & Co., Detroit) often dispensed for pregnant or lactating women:

Dicalcium phosphate (anhydrous)	500 mg.
Ferrous sulfate	75 mg.
Folic acid	1 mg.
Rutin	20 mg.
Vitamin B_1 (thiamine hydrochloride)	3 mg.
Vitamin B_2 (riboflavin)	2 mg.
Vitamin B_6 (pyrodoxine hydrochloride)	1 mg.
Vitamin B_{12} (crystalline)	2 mcg.
Vitamin C (ascorbic acid)	35 mg.
Vitamin K (synkamin, the hydrochloride)	0.5 mg.
Nicotinamide (niacinamide)	10 mg.
Vitamin A	4000 units
Vitamin D	400 units

The contents of one capsule, as listed, was divided into two equal portions and one portion thoroughly mixed with one pulverized, hard-boiled chicken egg of large size and antibiotic added:

Aureomycin hydrochloride	125 mg.
Methylparaben	45 mg.
Propylparaben	11 mg.

(The parabens are fungus inhibitors now dispensed with many Aureomycin preparations by the Lederle Laboratories division of American Cyanamid Co., New York.)

The ingredients listed were made into a semi-wet paste to be extruded through a $\frac{3}{8}$-inch nozzle into the begging birds' mouths. Even the older martins that had been feeding themselves for weeks would accept some of this mixture before going to roost.

The mixture was consumed by seven to ten birds each evening during the pre-roosting lineup. Twice a week, some finely crushed egg shell was added.

The possibility of using mealworms, the larvae of the beetle *Tenebrio molitor*, as martin food was investigated. The exoskeleton of these larvae is tough and apparently somewhat resistant to the martin's digestive process; however, the mealworms must be an excellent source of protein, and about 3000 of them were used during the summer of 1952. The worms molt as they grow and the freshly molted larvae are pale, tender morsels which must be utilized rather soon, for within a few hours the worm is again covered by a glistening, tough coat of brown. The mealworms make better food if cut transversely into half-centimeter sections. Like all other foods, except live or fresh, flying insects, these worms do not appear to be a suitable all-round food but are a good dietary supplement. When given generous helpings of the mealworms, the juvenal birds regurgitate pellets of the exoskeletons. The birds make motions as if trying to sing, then shake the head from side to side and bring up the pellet without difficulty, casting it a few feet away from their perch. When many grasshoppers had been taken consecutively, the juvenal birds would sometimes bring up pellets of the legs and skeletons squeezed almost devoid of juice and nutrition. The act could be so quickly accomplished that I received the impression that the birds made use of this device more often than I formerly suspected. Pellets found in the roosting box or accidentally noticed on the ground was the evidence most often seen. I never saw a martin younger than ten days old bring up a pellet and assume that the older birds only do it when the diet is rather tough and coarse. One fledgling ejected a pellet made up of mealworm skeleton fragments and crushed egg shell that contained in its center a large carpet tack. The tack may have been given to the bird by one of its nest mates or by an experimenting child. The young birds often pick up peat moss and other small objects within reach but, after mouthing them, always flip them away by shaking the head.

The necessity for calcium in the diet of young birds is paramount and both nestlings and juvenal birds accept small pieces of chicken egg shell as if it had a delicious taste. A small amount of powdered egg shell was included in the daily diet of newly hatched martins. Wild Purple Martins have never tried to feed insects to the hand-raised birds, but in 1951 an adult female alighted near one of the fledglings and offered it a piece of egg shell whereas on another occasion the oldest of the group of hand-raised birds in 1952 was observed to bring a piece of egg shell to the youngest of the group.

Martins get their water from the insects they eat and the giving of water, even in small amounts, to nestlings is soon followed by watery feces. In feeding newly hatched martins, if the small insects have been dead more than a few minutes, they can be momentarily dipped in water to re-hydrate them. In general, the amount of moisture given can be regulated by the appearance of the droppings. The young birds will drink water as if they appreciate it but apparently they do not need it. On a very hot day, fledgling martins enjoyed wading in the inch-deep bird bath provided for them to cavort in. There is apparently a reflex which causes them to open the mouth when they enter the water. While squatting and wading about they keep the mouth open and the chin touching the surface. Water does not always get into the mouth, but they frequently seem to swallow a little. On a day of low humidity, the older, foraging juveniles at times came in late in the afternoon to drink water like thirsty chickens; then their droppings showed that they had been feeding on small, black, flying ants. The younger, hand-fed birds that are getting grasshoppers and other relatively juicy insects need no water.

BEHAVIOR OF HAND-RAISED MARTINS

There is something soul-satisfying in raising any young, helpless thing and being the object of its pleadings for food. To satisfy the hunger of a baby bird and watch its

daily, almost hourly, growth gives one a feeling of accomplishment and perhaps appeals to the maternal instinct in us all. The person who finds a fallen nestling can accomplish more with less effort if he first backs away a considerable distance to watch and see if the parent bird is not in attendance on the young one. But if the foundling is a naked, helpless bird, the finder would save both energy and birds by getting ladders or whatever help is needed to replace the young in the nest. Even a different nest, providing it contained young birds, would be better for all concerned than attempting to hand raise a young bird in most instances. The hand raising of Purple Martins in the present case was undertaken as a means to an end and not to satisfy a thwarted instinct.

At the age of about eight days, the hand-raised Purple Martin nestling begins to develop its personality as it peers at the immediate surroundings through recently opened eyes. It begins to address pleadings for food to the nearest person rather than straight overhead, and when hunger is finally eased, the young one spends considerable time inspecting its host and making satisfied, clucking chirps. The readiness with which the young Purple Martin cooperates in hand feeding is notable even in wild birds taken from the nest at the age of two weeks. These nestlings having first been force-fed several times will begin to beg for and accept food within three or four hours after capture. Brauner (1953) found it necessary to force-feed a 15-day-old Poor-will (*Phalaenoptilus nuttallii*) for eleven days after taking it from the nest before it voluntarily took food from a forceps. In 1952, I took three Purple Martins from the nest at the age of 30 days, and they required forced feedings for only 36 hours when one of them carefully took a grasshopper from the forceps; the remaining two gave in within an hour.

The obvious comfort and sense of security a nestling derives from presence of nest mates makes the raising of a single bird less interesting. Martins have a strong social bond to one another and this tendency is noted as soon as they can see and crawl about. Each evening near dusk, the birds become playfully aggressive and contend with one another but will join together in a defensive attitude with owllike popping of beaks in the direction of anyone approaching too near the box. This ferocious bluffing is noted only at roosting time and is very amusing in pin-feathered birds. They crowd together in a corner to sleep, resting on their underparts. The younger birds sleep or remain inactive for a while after daylight each morning unless awakened and are not as hungry early in the morning as one would expect. As the day advances, the appetite increases and reaches its amazing plateau from about three until six in the afternoon.

The young martins are peculiarly alert to moving, airborne objects. All but invisible, floating particles of lint in the air would attract the attention of several birds at once, whereas I could locate the object only by scrutinizing the point of their converging attention on the moving bit.

In order that they might exercise, the birds were kept in a large tray, the bottom of which was covered with peat moss. This material is soft and comfortable to the birds' feet while its absorptive qualities facilitate sanitation. While in the bird box, the pin-feathered martin moves to the perimeter of the nest to deposit droppings, generally in a corner of the box. As soon as it is more agile, it backs up to the entrance hole and deposits on the porch. Whereas the younger birds are rather careless, the older fledglings and juveniles, when capable of flight, rarely soil the premises but move to the edge of the porch or fly away from the box as I have often seen adult martins do only to return at once after defecating in flight, a few yards away.

The young birds have a reflex to defecate with any major change of location, as when carried from the peat moss tray back to the bird box. When placed on the porch, they immediately head for the door but pause to defecate just before entering. A bird that has emptied the cloaca prior to the change in location will pause at the threshold

and go through the motion of defecating before entering the house. Another reflex which is strikingly demonstrated is that elicited when well feathered nestling martins are suddenly placed in strong sunlight. The nestlings at once drop over on one wing, turn the head horizontal, close the eyes and erect the feathers of the head and neck so that the sunlight reaches the epidermis. They raise the wing on the side toward the sun so that it points at the sun and the rays reach into the axillary space, side of the breast and abdomen; then they remain motionless, except for respiration. I did not wait to see how long a tray of the young birds would maintain this unusual tableau, but after a minute of exposure I always removed them to the cool shade where they would recover their usual stance and begin moving about again. I assume that this hurried, maximum use of sunlight is an instinct of a heavily parasitized, hole-nesting species.

When the birds were fully feathered, they were eased into a 1-inch deep bird bath during the hot part of the day. They would usually stand still with the mouth open and often would defecate, but when martins have been flying for some time and are self sufficient, they apparently never soil the bird bath. On the first trip to the wading pool some of the juveniles began to squat and flutter in the water at once while others waded swiftly about with the chin barely resting on the surface. An occasional martin does not seem to care much for the wading pool at this age, but most of them do and three of the birds took from two to four spontaneous baths daily. Some of these wading sprees were just to cool off the feet and the belly, but at other times the birds would get wet from head to foot so that flying was difficult upon taking off from the elevated wading pool and repeated, vigorous shaking was done in flight to cast off the water. The hand-raised martin's method of using the bird bath was to squat and run through the water with tail and chin on the surface and with only an occasional flipping of water into the feathers. Thus they seemed to approach as nearly as possible bathing while in flight.

For several days before attempting the first flight, the young birds grip a perch and fan their wings vigorously many times a day. This exercise usually lasts from ten to twenty seconds and reminds one of a plane warming up engines, especially when the dust and peat moss begins to fly. Although the birds can fly a little if tossed into the air at this time, they apparently know by the pull exerted on their feet when they should attempt an excursion, which they soon do by choosing a nearby destination, leaning as far toward it as possible, and then barely making it amid considerable excitement. The behavior is contagious, but one or more birds are usually a day late in making their first flight. Proficiency in the air comes rapidly thereafter, and the 30-day old martin begins to fly like an adult. The trick of smooth landings comes more slowly, however, and usually requires several days of practice.

Before the young birds learn evasive tactics, they are frequently disconcerted during flight when other birds pursue them. Finches, robins and other swallows take special pains to harass them by flying below and behind the juvenal martin and nipping at its tail feathers and feet. Immature robins and adult Tree Swallows were the worst offenders. The latter would approach the martin during flight, while the robin would perch beside the martin for several minutes in a peaceful attitude only to pursue the newly flying bird the instant it took flight. Some tail feathers were lost in these attacks. Ten days later, the martins can outfly the lot and apparently consider the pursuing birds minor nuisances.

As the young martins begin to perch on wires in the immediate neighborhood, they frequently sidestep rapidly along the wire to approach and associate more closely with nearby birds. They are especially curious about birds their own size or smaller. When a mature or juvenal American Goldfinch (*Spinus tristis*) would alight close by, a sidestepping approach was used, only to have the finch take flight when the martin came

too close. Emlen (1952) showed that the Purple Martin has a tendency to perch less than four inches from adjacent martins, which distance in the case of the finches was too near. The juvenal martins never showed signs of aggressiveness as they approached other species nor did they pursue any bird taking flight.

The approach of larger birds of any species would produce alarm calls from the first martin taking notice, and the call would be echoed by the group as it took wing to disperse. This reflex was brought out almost daily by a pair of low-flying Green Herons (*Butorides virescens*) which nested nearby. The Red-shafted Flicker (*Colaptes cafer*) and domestic pigeons caused the alarm reaction frequently when flying low in the direction of the loafing, juvenal martins. On one occasion, I noted that two falcons, swiftly coursing directly overhead, but at about 200 feet altitude, caused no sign of alarm in any of the perching martins. During 1951, while I was handling three fledgling martins that had been on the wing for only a day, a Cooper Hawk (*Accipiter cooperii*) whizzed by my ear in a dive toward the birds, then banked sharply a few yards away and came back toward the birds but desisted when I yelled and gestured. At the time, we were on a second story sundeck, and the young birds, perched on the railing of the deck, did not show fear or give any alarm note prior to or during the incident. The handling and feeding of the noisy young martins frequently caused birds of other species to alight nearby from curiosity. The finches and small sparrows most often came near and showed considerable concern about the proceedings.

As soon as the juvenal martins are adept at flying, they can be seen to make occasional and often unsuccessful attempts to catch flying insects. Then they are out early each morning foraging for themselves but still getting considerable food from headquarters. At midday, they usually perch on high electric wires behind our lot or out in front where they seem interested in watching a busy thoroughfare; however, for about ten more days they keep an eye on the back door for the man with the grasshoppers. At this time, to encourage their maturation, I fed the birds liberally only once during the morning and again just before going to roost when they were given all they would take. In the late afternoon, if they beg for food and get none, they will fly out and hunt as a group. When I hunted bees and grasshoppers for them, they would circle about overhead or perch nearby and come sailing in a direct line when I gave the come-and-get-it signal, which was a loud, high-pitched "Hey" called out as the insect was held aloft in the tip of a forceps. The birds would come from perches 75 to 150 yards away when moderately hungry. They would perch on a proffered finger or wrist and assume a begging posture with wings vibrating and mouth gaping, and they were quick to compete for each insect as it was caught and held out toward them. Occasionally in the melee, a bird would swallow an inch or two of the feeding forceps and more than once a martin flew head-on at the grasped insect and impaled itself on the blunt blades of the forceps while my attention was taken by one of the other birds. No discomfiture resulted as far as behavior or subsequent appetite indicated.

As the martins mature, they become more selective about artificial feeding as well as less tame so that they often fly down in response to a call but take off without landing if they see no food in evidence. Then they were gone for longer intervals each day until I saw them perching only in midday and anxiously awaited the thrill of their return about an hour before dusk each afternoon, when they would suddenly appear in a scattered group high overhead and drop down individually to perch on the wires or come directly to my hand if hunting had been poor. After first getting damp in the bird bath, they would spend the hour perching and preening in the remaining sunshine striking the high wires. Some of the martins habitually landed on the flat surface of the wooden crossarms of the power pole where they continually walked back and forth around and

under the glass insulators as if in play. It was necessary for them to squat as they passed under an insulator; this activity had been a favorite one for the hand-raised martins the previous year. On two occasions I saw a young martin, which was preening on a wire following a bath, suddenly hang head down from the wire with clinched feet and remain motionless for ten or fifteen seconds with wings outstretched, ventral surface toward the sun. I thought this behavior unusual, but Davis (1944) observed inverted, soaring flights of several yards by Purple Martins, and I recalled the agility of these birds previously as they perched on a slick, plastic clothesline; several times one leaned too far forward in trying to reach an insect, turned a complete flip, and regained its normal perching position without having let go of the line.

The success of the day's hunt could be gauged by the hunger shown each evening. During one brief spell of cool, overcast weather some of the birds that had been feeding themselves for two weeks came in and asked for food. The oldest martin was then 75 days old and the three youngest were 34 days of age.

Playful aggressiveness was evident at roosting time when the first bird inside a box would try to keep his mates from entering by guarding the door with snapping beak until those on the porch became impatient and shouldered their way inside. Then all would be quiet except for an occasional, satisfied peep. The birds in each age group crowd together in their box so that they are in maximum contact with heads partially hidden under mates' shoulders and breasts or jammed into the corners of the box. The older birds sleep standing upright with feathers slightly erect while very young birds squat on their lower breast and underparts. The upper eyelid is the last spot to become feathered on the young bird and this tender, relatively naked point gives mosquitoes an opportunity to annoy the sleeping birds considerably. Some palpebral redness and swelling resulted from this cause before the boxes were screened.

As the time for migration approached, the number of birds returning in late afternoon to roost decreased. The oldest bird was the first to leave permanently. This was on August 17. On the 18th the nine remaining birds roosted in the boxes. During the last ten days the group dwindled as indicated in table 2. Two of the last birds to leave

Table 2

Last Records of Purple Martins at Roost Prior to Migration in 1952

Day of August	Number of birds returning in p.m.	General behavior	Food taken	Number of birds spending night
19th	7	calm, friendly	few insects; egg mixture	7
20th	5	calm, aloof	egg mixture	5
21st	3	calm, aloof	egg mixture	2
22nd	4	flighty	egg mixture	4
23rd	4	flighty	egg mixture	4
24th (cloudy)	5	calm, friendly	insects and egg mixture	5
25th (cloudy)	5	calm, friendly	many insects and egg mixture	5
26th	5	flighty	4 ate; 3 departed	2
27th	2	nervous	no food taken	2
28th	(3 birds last seen in mid-morning)			0

were considered to be males as judged by their behavior, and this circumstance gave some encouragement to hope for the return of the martins the following spring, since the male Purple Martin scouts for a nesting site each year. The two suspect males were not the youngest of the group but they seemed more attached to the roosting boxes and remained after the other three birds in their age group had gone.

SEX DETERMINATION

Sex determination is not possible in the living, young Purple Martin until the age of one year when the males begin to show an occasional black feather on the breast or neck. Although the plumage is identical with the female at this age, except for the rare black feather, the year-old male may successfully mate and its sex thus can be determined by its actions. After raising a group of Purple Martins and watching their behavior, I have the impression that certain ones are males as judged by their behavior and song. There does not seem to be any difference in size. By repeatedly checking

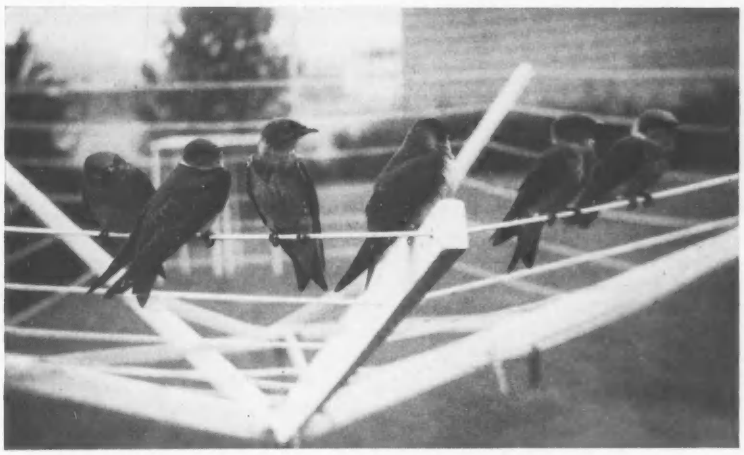

Fig. 1. Pre-roosting lineup of juvenal Purple Martins.

bands, I found that the three most aggressive and self-reliant birds had voices of lower pitch and more melody (in the begging chirp) than others in the group. One of these three flew down and mounted, in simulated copulation, a fledgling martin which had fallen to the ground and fluttered with outstretched wings. Two of the suspect males attempted more complicated songs of successive, variable notes on more than one occasion while sunning. Some martins give a frequent, loud peep while yet inside the egg before getting completely free and then continue to be vociferous, while others make no sound for the first few days of feeding. Some correlation between sex and early use of the voice may possibly exist.

SONG OF JUVENAL MARTINS

Until the birds are about five weeks old, they make use of the begging chirp almost exclusively. This is similar to the chirp of an adult English Sparrow but slightly more prolonged. Besides a few weak, piping half-chirps given when hunger is satisfied and sleep is overpowering, the young martins make three other sounds. A cat-like, screaming noise is made by many birds while struggling to get away when they are being held or hurt, and a trilled, lower pitched, ascending note is uttered as a group warning whenever a cat or dog comes near or when a large, unidentified bird is approaching. This last sound is very similar to the alarm call of the Cliff Swallow (*Petrochelidon pyrrhonota*). The third sound is a mechanical, clicking noise of low frequency produced while the beak is widely opened in a menacing attitude during squabbles between mates.

At about six weeks of age the juveniles begin to produce some guttural, martin-type noises, and occasionally one will sing two or three low, warbled notes consecutively with much movement of the chin and throat feathers. Certain individuals within a given age group sing more than others; whether these are males has not been determined. At this time the typical *pee-you* call is given by one or more birds at times of great excitement. This note was heard most often when the birds were released from their bird houses early in the morning. This circumstance came about because mosquitoes were pestering the birds on the roost, so a piece of screen was put over the entrance hole as soon as the last bird retired. The screen was so placed that the birds could usually dislodge it in the morning; but on some occasions the older birds were still shut in at six in the morning, the other birds having meanwhile departed shortly after daylight. When the barrier was removed, the impatient birds would give this familiar call as they took off on their delayed hunt.

VISITS BY ADULT MARTINS

In 1951, when only three Purple Martins were hand raised, both male and female martins came to visit briefly with the young birds on several occasions. These visits were usually late in the afternoon, and the wild birds often would only circle the place and fly away. An adult female made almost a daily appearance, flew down near the residence when the birds were being handled and flew near them often in a harrying manner as if urging them to fly with her. It is interesting that although she acted in a nervous and apprehensive manner when she first began to visit the fledglings, she never uttered a sound that I could hear even when she flew within a yard of me in pursuing the young. After the three birds were more proficient at flying, they were absent for long intervals and would often return in the company of an adult female thought to be the same visitor.

In 1952, a wire recording of Purple Martin song and chatter during nest building activity was made at the colony on the Umpqua River drawbridge. A permament, plastic record was made and when martins were seen at a distance of about a mile from my home, the record was amplified through a six-foot trumpet loudspeaker in the direction of the observed birds. Within five minutes, three martins came in at about 150 feet elevation and looked the place over. This experiment was tried again on another day to be certain that it worked and then discontinued to await the time when hand-raised fledglings would be about the place. It was during one of these broadcasts that Tree Swallows were observed flying out to attack approaching martins.

When the first hand-raised martin of the season was flying about fairly well, the recording was again broadcast and within five minutes an adult male martin perched on the wire beside the fledgling for a minute. While subsequently acquired birds were nestlings and fledglings, the record was often played for their benefit and they always halted their activities to listen raptly.

After the local martins discovered the presence of the hand-raised young, they came around daily and the recorded sounds were not broadcast again, except on two occasions at sundown when a young martin on its first or second day of flight went too far or seemed to stay too long; then the sound was turned on as a possible beacon to aid the lost bird. One of the birds returned during the broadcast, whereas the other did not return until early the following morning. Several times at midday when no birds could be seen, the sound was turned on and some or all of the juveniles came in and accepted food.

Another method used to attract martins to the location was the provision of a source of calcium visible to flying birds. A mixture of crushed chicken egg shell and oyster

shell was spread thickly over an area of a square yard in two places out in the gravelled parking area adjacent to the back yard. The visiting martins located it within a few hours and both sexes made daily trips thereafter to eat and carry away some of the material. They definitely preferred the egg shell. Judging from their angle of flight as they ascended, they were nesting at a considerable distance, for they were still climbing as they disappeared in an 8-power binocular field. One of the piles of shell was only twenty feet from the nearest cover but the other was sixty feet out in the clear. The martins sometimes came to the nearby spot but usually preferred the square in the open over which they would often make a dozen passes before cautiously alighting. Such caution was probably displayed by newcomers to the calcium bonanza, for other adult martins came in and landed on the first approach. I thought that from five to ten adult birds made use of the shell but I never saw more than four birds in a group at the shell. The banded juveniles did not visit the shell piles to my knowledge. They were receiving some egg shell almost daily in their egg mixture.

Since a larger group of birds was hand raised in 1952 and the recorded martin song as well as the egg shell were added attractions, there were many more visiting martins in 1952. Most of the visitors were adult females. Often a group of five or six martins would approach the neighborhood and the males would continue to circle about or fly at a distance while the females from the group would come near or perch on the wires for a few minutes. One large black male came in, dived at my head, and rejoined the waiting males sailing about nearby.

One of the most frequent visitors in 1952 was a year-old martin that came on several consecutive mornings, alighting on and inspecting the same duplex house on a pole. It was then July and too late for nesting. This bird was not wearing a leg band as far as I could determine, although the bands are difficult to see against the almost white underparts when the bird is overhead; also, when perching, the martin rests the tarsus against the feathers of the abdomen. Bands are easily seen when martins walk on the ground.

Most of the visiting martins came in July and August by which time the Tree Swallows had completed nesting and most of the families had flown; so the martins did not encounter any opposition in these months.

In 1953, seven juvenal martins that were hand raised helped attract visiting martins, but no nests resulted. The egg shell was a very strong attraction with martins arriving singly and in small groups at all hours of the day. About fifty martins came down to the calcium daily and certain groups and individuals came at the same time each day. Some of these were banded birds from the previous year. Two banded immature males and one banded immature female were observed in one group on the ground. Mature and immature martins spent considerable time loafing on the wires. A one-year-old female mixed with the hand raised birds daily and lit on the various bird houses. This bird tasted a mealworm I held out to it in a forceps; it was not a banded bird.

AMOS AND ANDY

The details about two of the ten birds raised in 1952 are out of the ordinary. The bird called Andy was taken from a nest in old piling on Lake Tahkenitch on the Oregon coast at the age of about 4½ weeks. Three birds of the clutch were taken from the nest, while a fourth bolted and flew 100 yards to the shore without great difficulty. The three captives were taken home for hand feeding, although they were obviously about ready to become self-supporting. They were kept inside the residence at a window but not otherwise confined. It was necessary to force-feed them for the first day and a half after which time they began to take food voluntarily. After only six hours of voluntary feeding, the three were banded and released because they spent most of their time trying

to get through the window glass. The three flew off together giving a loud *chirrup* at regular, long intervals. They flew into the wind and remained in flight for ten minutes before they returned to nearby wires to rest; then they flew away together. There was considerable swallow activity at the time and an abundance of insects flying about. This was the deciding factor in releasing the three, able birds after less than 48 hours of captivity.

Fig. 2. Andy returned for a grasshopper after only 48 hours of captivity.

There was, at this time, only one hand-raised martin flying about the place. This was Amos, hatched from an Arkansas egg seven weeks previously. On the afternoon of the third day following the release of the three newly acquired birds, Amos came home accompanied by another martin. They perched high on the wires, and Amos was called in and fed. An insect was then held out toward the strange bird and to my surprise, it sailed in and landed at my feet when I called. I picked it up. This was one of the three recently banded martins, and it was obviously quite hungry, accepting food eagerly, although its droppings demonstrated that it had been eating flying ants. This martin, then named Andy, remained as one of the house-roosting martins for the next 41 days during which time he was aloof and self-sufficient but accepted food each evening before going to roost and could be coaxed on occasion to step up and perch on a finger in order to get his egg mixture. I am of the opinion that this bird is a female, in spite of the name. Its two mates were not seen again as far as was known, although one or two immature martins visited during the remainder of the summer; often while feeding the group of hand-raised birds, I would hold up a grasshopper toward the visitors on the electric wires and call to them, and they would lean forward as if tempted to come

down. Occasionally one would make a pass down almost to me but climb steeply as its courage failed.

Amos is also a female, I believe. Having been hatched in an incubator and completely raised by hand, Amos occupied a favorite position in relation to the members of the household. Obviously jealous and ill at ease when other birds were subsequently brought on the scene, she nevertheless made friends with Andy (fig. 3); later, when five nestlings were brought in, Amos, at the age of only 54 days, began to walk over the little ones as if brooding them and soon began to bring insects to them. This help was appreciated, and the good work was encouraged by giving her insects to give the nestlings; but Amos would be gone for five minutes when I could see no flying insects and return with insect wings and legs protruding from both sides of her bill. She fed the

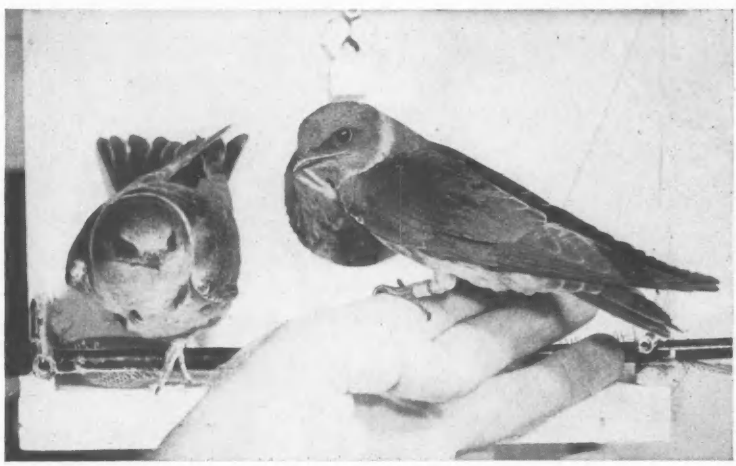

Fig. 3. Amos and Andy in detail; nestling in background.

young birds every morning and frequently in the afternoon (figs. 4, 5). Eight consecutive trips were counted at one feeding period in a thirty minute interval in mid-morning.

Prior to feeding herself, Amos had gone insect hunting daily, perched on my finger or on a short, wooden, T-shaped perch, as I waded in the grass and weeds. She would grasp the perch or finger firmly with her toes and lean far forward to snap an insect off a leaf, or occasionally I would carry her along under a slowly flying insect and she would snap it out of the air. Soon, she was springing into the air after flying insects and circling back to my hand to perch and await her next victim.

Later on, when she began feeding the nestlings, we would go hunting and she would perch on my finger, accepting insects that I caught and meanwhile catching some herself. Carefully saving them until she had a mouthful, she would fly 100 yards to the bird box, feed the young birds and return to my hand to start collecting another five or six insects before returning to the bird house. Amos once made six consecutive trips of this type in 45 minutes.

As the five well tended birds began to fly, Amos was successfully transferred to feeding three younger birds just added to the aviary, but her previous charges were not easily weaned and would gang up on Amos whenever she arrived with food for the

smaller birds. In spite of my praise and assistance, Amos could not see the profit in following her precocious instincts to the extent of trying to feed eight birds; so she gave it up. Several days later she was observed to bring a piece of egg shell to one of the smallest birds.

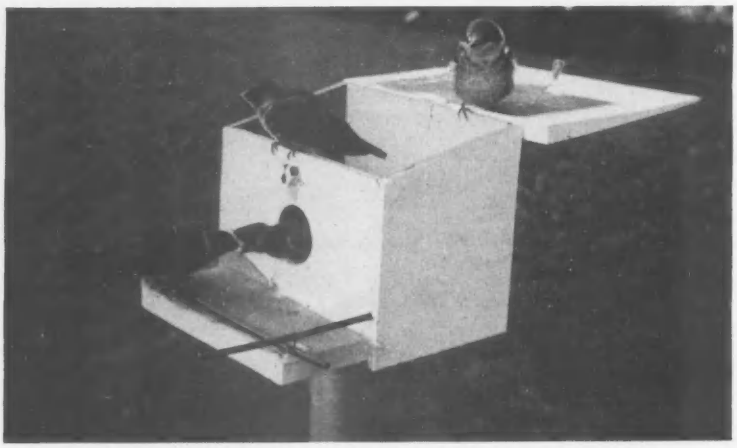

Fig. 4. Amos feeding nestling.

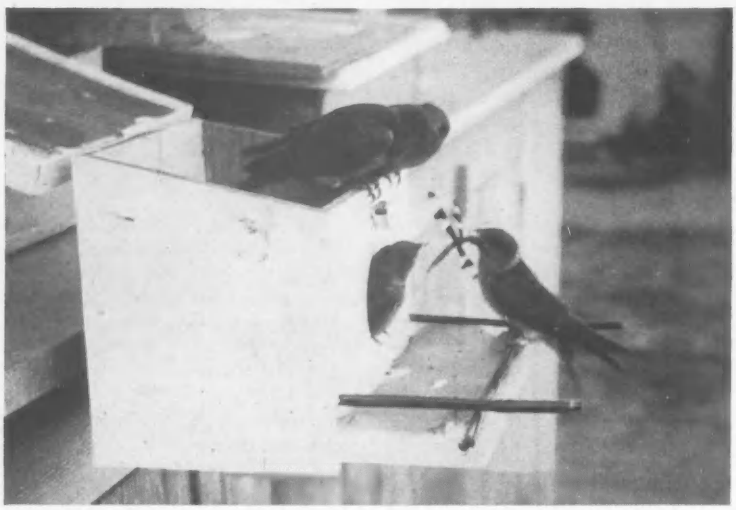

Fig. 5. Amos brings a large dragonfly; the fledglings inspect the food before eating it.

Amos was the only bird of the lot that would fly down and perch on the finger for purely social reasons. Hunger was always the motivating impulse causing the other birds to flutter around and land on head and shoulders when one approached. Amos would

often fly down from her perch and stand nearby waiting for a proffered finger to perch upon. Without touching it, she would refuse all food with the negative shake of the head that birds use when they wish to flip something from the mouth; she only wanted to sit and give a tiny, whistling peep now and then. One evening after dark, while I worked in the shop, she quit her roost and flew into the shop apparently to investigate the noise made by the table saw and to watch me work. In the afternoon, when I was hunting insects in the grass and weeds with all the younger birds flying around contending for what I caught, Amos, often having been gone all day, would suddenly fly in and land on my wrist if it was unoccupied, or if birds were there she would fly around me peeping helplessly until I would "shoo" the others away and receive her. Part of the time she was not hungry and only wanted to be the object of my attention. When other pets would come in and land she would take flight, but I could call her back if I dispersed the other juveniles.

Amos would often not roost in a box with the other birds but tried many different places about the eaves and windows. At dusk, she sometimes came into the residence through the window-opening-hole in the screen and would fly along the ceiling beams looking for a roost. But the madre domo of my establishment thought that birds should roost outside; so Amos would be escorted out to try another roosting spot. She would sometimes use a separate box I had put up for her, but she would not mix with the other birds, or if she entered a box first, she would leave when others crowded in to roost. Occasionally she would not show up to roost and would be brought over on the finger of a neighbor whose company and house she had chosen for the night. Often I would not see her for 24 hours. She took her final departure on August 17 at the age of 80 days.

SUMMARY

In the southern Willamette Valley of Oregon the Purple Martin is a common summer resident. It nests in inaccessible places perhaps because the less social and very abundant Tree Swallows and Violet-green Swallows arrive a month or more earlier than the martins and successfully monopolize the small number of suitable bird houses. The fact that the Purple Martin inhabits remote areas in this region makes it unknown to the general public, and it is seldom seen by those interested in birds.

Purple Martins are colonized in boxes hanging under the eaves of powerhouses atop railroad drawbridges over the Umpqua and Siuslaw rivers on the Oregon coast. One of these colonies dates from 1944 and the other was established in 1952. Martins utilize bird boxes at some points in the neighboring states of Washington and California, and the coastal cities of these states have often had Purple Martins nesting about business buildings. No instance of utilization of a traditional, colonial martin-house on a tall pole has been found in Oregon, nor has any such site been reported recently from the west coast states.

As the Purple Martin is dependent upon a highly specialized nesting site for which competition is keen, some active help for this long-time friend of man will likely be necessary to establish the bird in artificial nesting sites in urban areas. The recent inauguration, by major lumber interests, of a program for widespread felling of dead trees as well as the spraying of forests with DDT makes logical the effort to adapt Purple Martins to bird houses at this time.

Over a five-year period, various means were used to attract Purple Martins in an endeavor to establish a martin colony at a suitable urban location at Eugene, Oregon. Fourteen nesting boxes containing 40 adequate units were erected at the urban location and elsewhere in the vicinity during the five-year effort with only one observation of interest in a box by a Purple Martin. Tree Swallows, Violet-green Swallows, Western

Bluebirds, House Wrens and English Sparrows nested in the boxes with only 50 per cent of the available space utilized. Only the sparrows encountered active human interference. Incomplete nest building and fighting by Tree Swallows occurred around all the houses during March and April, and in this way Tree Swallows tied up considerably more space during the nest building season than they ultimately used.

A more successful means of attracting Purple Martins was the use of recorded and rebroadcast martin song, a ruse which almost invariably produced visits from nearby martins within a few minutes. This method was used with restraint to advertise the presence of fledgling martins that were being hand raised at the site of the intended Purple Martin colony.

The hand raising of Purple Martins has produced house-conscious, juvenal birds friendly to man and roosting in bird boxes until time for migration in late August. At the time of migration, the youngest birds were 45 days old and the oldest bird was 80 days old. The latter was self-reliant during the last seven weeks of its stay and helped feed the younger birds. The presence of young martins brought daily visits by adult martins, most of which were females.

The proposed site for a martin colony was made more attractive to wild Purple Martins by providing a plentiful supply of calcium (chicken egg shell) visible to flying birds. The eager utilization of calcium by Purple Martins suggests that this element is a necessary supplement to the 100 per cent insect diet, especially in regions where the soil is low in calcium.

Those wishing to attempt establishment of a Purple Martin colony should provide multiple-unit boxes with entrance holes of at least 2½ inches diameter and rooms no smaller than 7×7×7 inches. In areas where the Tree Swallow is abundant, active help may be necessary, at least to the extent of postponing erection of martin houses until mid-April or later, and then discouraging Tree Swallows from dominating the location.

ACKNOWLEDGMENTS

A great deal of help has been received in the work with the birds at home and in the field work incidental to it. Ben Pruitt has been a most generous and interesting consultant and companion both in the field and on the telephone. Alden H. Miller has given many valuable technical suggestions and points of information. Mrs. Hazel Judd, editor of Oregon's *Audubon Warbler*, assisted with the questionnaire and has for several years publicized the martin project so that much valuable correspondence came in. I am indebted to Mrs. Margaret M. Nice of Chicago who has been a stimulating correspondent. All who are especially interested in Purple Martins will feel this indebtedness if they can refer to the publication by Allen and Nice (1952) which deals so comprehensively with this bird.

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A METHOD FOR THE OBJECTIVE STUDY OF BIRD SONG AND ITS APPLICATION TO THE ANALYSIS OF BEWICK WREN SONGS

By WILLIAM R. FISH

The structures of the songs of birds are usually so complex and variable that the human ear is unable to perceive them accurately. For this reason nearly all studies of bird song have been largely of a subjective nature and have furnished little information for the development of a precise knowledge of bird song itself or for the support of taxonomic and behaviorial investigations.

For the objective analysis of bird song suitable methods are required for the measurement of frequency, amplitude, and time. For a number of years methods have been available for the quantitative determination of each of these factors, but little attention has been given to the analysis of the complex patterns of tones found in the songs of birds. Brand (Auk, 52, 1935:40-52) made measurements of the pitch and time of bird songs by using a low-power microscope in examining recordings made on sound tracks on motion picture film. In that paper and in a later one (Brand, Auk, 55, 1938: 263-268) he reported the lengths of the notes and songs of a number of birds. He also listed for a large number of passerine species the maximum, minimum and mean values of the "pitch-giving" frequencies found in their songs, and for the Meadowlark, Goldfinch and Bob-white Quail he presented graphical representations of examples of their songs or calls plotted on charts of pitch versus time. Axtell (Auk, 55, 1938:481-491) employed Brand's method in his studies of the song of the Kirtland Warbler. The "sound spectrograph," which was developed by Potter and co-workers in 1945 for the analysis of sounds of speech, prepares from a recorded sound of short duration a chart depicting along a time scale all the major frequencies present in the sound. Several examples of records prepared on this instrument from bird song recordings supplied by the Albert R. Brand Bird Song Foundation appear in the publication "Visible Speech" (Potter, Kopp and Green, 1947, D. Van Nostrand). Commercial versions of the "sound spectrograph" have recently been placed on the market.

The purpose of this paper is to describe a new method for the analysis of bird song. The method has limited possibilities for use in the field, but for many reasons it is of great potential usefulness when applied to the analysis of recorded songs. An assembly of commercially available instruments has been devised which produces inked tracings representing frequency with respect to time. These tracings may be used to study the patterns of notes, the pitch and duration of each note, and the intervals between notes and between successive songs. The equipment to be described does not measure amplitude, but this measurement can be made by the addition of relatively simple circuits and suitable calibration of the recording equipment. Those factors which contribute to the timbre of bird songs cannot be measured except by resorting to considerably more complex equipment and techniques.

EQUIPMENT

Figure 1 is a block diagram of the instruments used in this work. The nature and function of each instrument will be described in the following paragraphs. Although the instruments are designated by the names and model numbers of specific manufacturers, it is not implied that equivalent instruments of other manufacturers are not equally suitable.

Tape recorder.—The Magnecord tape recorder (Model PT6–JAH) is used also in the field for the recording of bird songs. In the field the synchronous motor of the recorder is operated from a 110-volt, 60-cycle power supply accurately controlled with respect to frequency. This is important, for in order to permit the greatest accuracy in the measurement of pitch and time, the tape must be

driven at the same speed during recording as during reproduction for analysis. The Magnecord recorder is provided with a 600-ohm output, which is connected to the mixing circuit, and with a 16-ohm output, which is connected to the Brush AC amplifier.

Audio oscillator.—The Hewlett-Packard audio oscillator (Model 201B) has a frequency range of 20–20,000 cycles per second (cps), which includes all frequencies likely to be encountered in bird

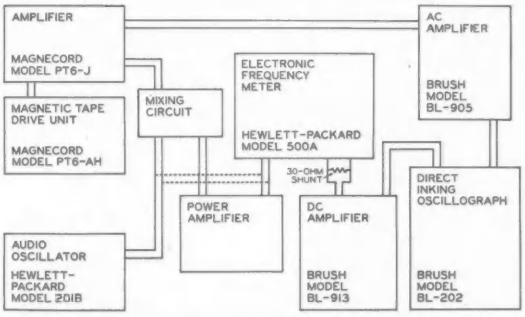

Fig. 1. Block diagram of instruments used for the preparation of oscillograph tracings showing the pitch and time factors of recorded bird songs.

songs. During the reproduction of recorded bird songs into the frequency meter, the 600–ohm output of the oscillator is connected to the mixing circuit. In this function a signal of low frequency is generated by the oscillator and mixed in the mixing circuit with the reproduced bird songs. Tape noise is of a random character and causes the frequency meter and oscillograph to respond in a haphazard manner in the silent periods between bird song notes. By mixing the low frequency signal with the bird songs, in the silent periods the oscillograph pen is drawn to the baseline of the oscillograph chart. The frequency of this signal is therefore chosen to correspond to that represented by the baseline, and its amplitude must be in the range between the amplitude of the noise inherent in the tape and that of the notes of lowest amplitude in the bird songs.

The oscillator signal may also be used to override background sounds inadvertently recorded with the bird songs. Their influence can be eliminated entirely without interference with the bird song notes of lowest amplitude, if the amplitude of these sounds is below the amplitude range of the bird songs. Useful tracings may be made by this method when the amplitude ranges overlap, but detailed analyses are not possible.

The oscillator is also used to prepare tapes containing signals of known frequency for calibration purposes. In addition, the oscillator provides a means of adjusting the range of the oscillograph. For this function the oscillator is connected directly to the frequency meter as shown by the dashed lines in figure 1.

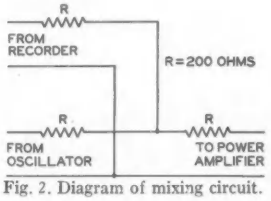

Fig. 2. Diagram of mixing circuit.

Mixing circuit.—The mixing circuit (fig. 2) is a simple resistive network. It permits the mixing of a signal of low frequency from the oscillator with the recorded bird songs reproduced by the recorder. The inputs have impedances of 600 ohms and the 600–ohm output is connected to the power amplifier.

Power amplifier.—The power amplifier provides sufficient amplification to produce at least 20 volts across the high-impedance input to the frequency meter when the maximum voltage across the 600-ohm output of the recorder amplifier is 0.75 volts. These specifications are given to ensure that the bird song notes of lowest amplitude will be fed to the frequency meter at a level of at least 0.2 volt. The ratio of the maximum to the minimum voltages at the input to the frequency meter (100/1) represents an amplitude range of 40 decibels (db), which is believed to be somewhat greater than is encountered in most bird songs. However, the margin is considered to be desirable. For proper matching to the mixing circuit the input of the power amplifier should have an impedance of 600 ohms. If the power amplifier has a high impedance input, the output of the mixing circuit should be loaded with a 600-ohm resistor.

Frequency meter.—The Hewlett-Packard Electronic Frequency Meter (Model 500A) is an instrument the direct current output of which, in milliamperes, is proportional to the frequency of the input signal. This proportional relationship holds with an accuracy of about two per cent as long as the voltage of the input signal is between 0.2 and 200 volts. The output circuit is designed to operate into a milliammeter of 1400-ohm impedance. Under the conditions used in this work the load across the output is 30 ohms, but the deviation from normal operation exhibited by the instrument is accounted for by the method of frequency calibration.

The Hewlett-Packard Electronic Frequency Meter responds to the frequency of greatest amplitude. This response to a single frequency occurs without interference as long as the harmonic frequencies have 3 to 5 db less amplitude. When the difference in amplitude of two or more frequencies is less than 3 to 5 db, the meter cannot distinguish the predominant one and oscillates between them. In order to determine the pitch of notes of this nature, filters are employed to reduce the amplitude of the interfering frequency or frequencies.

DC amplifier and oscillograph.—The Brush DC Amplifier (Model BL-913) and Brush Direct Inking Oscillograph (Model BL-202) ordinarily are used for the continuous recording of direct current voltages. The Model BL-202 oscillograph is a two-channel instrument with two magnetically driven pens which write side by side on a double-channel paper chart. The DC amplifier drives one of the pen motors; the second is driven by the AC amplifier as described below.

By placing a 30-ohm shunt across the line between the frequency meter and the DC amplifier, the amplifier and oscillograph perform as a recording direct current milliammeter which will respond to changes in the current of the output of the frequency meter as long as the changes do not occur at a rate greater than about 100 times per second.

AC amplifier and oscillograph.—The Brush AC Amplifier (Model BL-905) and the second channel of the oscillograph are connected to the 16-ohm output of the tape recorder for the purpose of making a time calibration record simultaneously with the making of the frequency record on the first channel.

METHOD

In the songs of birds changes in frequency may occur at a rate greater than 100 times per second, which is the approximate upper limit of the response of the magnetic motor of the oscillograph. For this reason it has been found that it is necessary, for the preparation of oscillograph tracings, to reproduce the bird songs at tape speeds less than that at which they were recorded. Tracings prepared from recordings reproduced at half-speed are useful for the study of the patterns of notes in songs and for the measurement of the duration of songs and notes, the intervals between notes, and the intervals between successive songs. However, tracings prepared in this manner may not show all the frequency changes involved. Consequently, for the detailed analysis of pitch the recordings are reproduced at one-eighth the speed at which they were recorded. When recordings are reproduced at reduced speeds the pitch of all tones is lowered by one octave for each 2 to 1 reduction, and the time factors are doubled.

During the preparation of tracings with the equipment described, the chart, on which a grid is printed, is driven through the oscillograph at a controlled, constant speed. If there is no signal fed into the system from the tape recorder, the oscillograph

pen (channel 1) rides on the baseline of the chart due to the signal from the audio oscillator, which is adjusted to perform this function. When relatively pure tones of sound are reproduced by the tape recorder, the oscillograph pen traces a line that is farther from the baseline the higher the pitch of the tone.

In order to calibrate the system with respect to frequency, a calibration tape is prepared by splicing together a series of short strips of tape on each of which is recorded a tone of known frequency. The calibration tape is spliced to the tape on which the bird songs are recorded and is subjected throughout the analytical procedures to the same operations as the tape containing the bird songs. Thus, at whatever tape speed used in the reproduction of the bird songs, a calibration curve is traced by the oscillograph immediately before (or after) the bird songs are traced, and the deflections of the oscillograph pen due to the tones of the bird songs are interpreted in terms of fre-

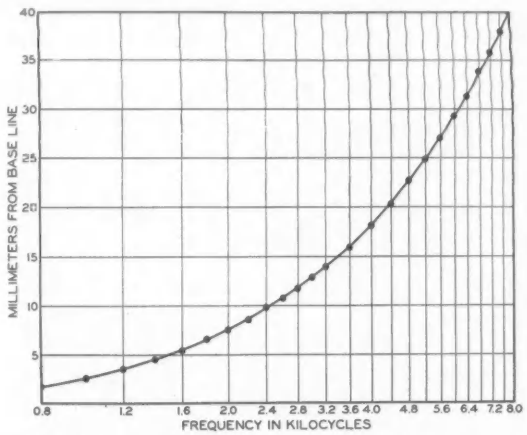

Fig. 3. Calibration curve for the interpretation of oscillograph deflection in terms of frequency.

quency by comparing them with the deflections due to the tones of known frequency on the calibration tape. Figure 3 is a plot of data obtained from an oscillograph tracing of a calibration tape reproduced at one-eighth speed. The dots on this frequency calibration curve indicate the frequencies used on the calibration tape, which covered the range from 800 to 8000 cps, and relate these frequencies (horizontal logarithmic scale) to the extent of deflection of the oscillograph pen from the baseline (vertical linear scale).

Time factors in the recorded bird songs are established by means of the following procedure. A 100–cps signal is recorded on tape, using the same recorder and tape drive speed used in the recording of the bird songs. A strip of this tape is also spliced to the tape on which the bird songs are recorded. During the preparation of half-speed tracings the AC amplifier and the pen of the second channel of the oscillograph respond to the 100–cps signal (50 cps when reproduced at half-speed) and there is recorded on the oscillograph chart a sine wave each cycle of which covers a length of chart equivalent to an elapsed time of 0.01 second. A portion of an oscillograph chart showing a time calibration tracing is reproduced in figure 4. It is seen that by appropriate meas-

urements and calculations the duration of time represented by the transverse reference lines of the chart is readily ascertained.

ANALYSIS OF BEWICK WREN SONGS

The use of the analytical method is illustrated by its application to the analysis of a series of 22 recorded songs of the Bewick Wren (*Thryomanes bewickii*). This series

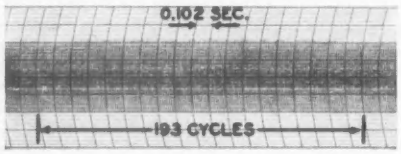

Fig. 4. Portion of oscillograph chart showing a time calibration tracing. The oscillatory line is made by a 100-cps signal reproduced by the tape recorder. The figures indicate the measurements and calculations required to determine the duration of time represented by the vertical (curved) reference lines.

of songs was recorded on May 23, 1951, about five miles west of Walker Pass in the eastern extreme of South Fork Valley, Kern County, California. The series was an unbroken sequence recorded from a male perched in a Joshua tree about 100 yards from the nest, from which young had left within the previous two or three days.

The recordings were made at a tape speed of 15 inches per second (ips) using plastic-base, red-oxide tape. The capacitor-type microphone (Stephens Manufacturing Corp., Model C–1C) was mounted in a parabolic reflector of 30-inch diameter located 45 feet from the wren.

Half-speed oscillograph tracings were made of the 22 songs by the method described in the previous sections of this paper. Examination of these tracings showed that all the songs were of the same pattern. In each of the songs the sequence of notes was the same, except for variations in the numbers of certain repetitive elements. In view of the similarity of the songs, one example was selected for a detailed frequency analysis, which is discussed below. The song selected for this purpose (no. 3 in the sequence of 22) is designated the representative example of the pattern. The pattern will be referred to as Bewick Wren pattern 1.

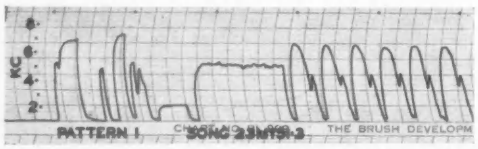

Fig. 5. Portion of oscillograph chart showing a half-speed tracing of the representative example of pattern 1 of the Bewick Wren song. The song number indicates the day, month and year of the recording and the number of the song in the sequence of 22 songs. The scale at left indicates frequency in kilocycles. The dots above the tracing are half-second timing marks.

The half-speed tracing of the representative example of Bewick Wren pattern 1 is reproduced in figure 5. A frequency scale is at the left and quarter-second timing marks appear above the tracing. Attention is drawn to the fact that the tracing is skewed to the left because the oscillograph pen swings in an arc. In addition, the frequency scale is greatly compressed relative to the time scale. In order to correct these deficiencies and to represent the song in a manner which will permit comparison with songs analyzed

by other equipment or other methods, a detailed frequency-time analysis of the pattern 1 song was made and the results plotted on semi-logarithmic coordinates.

To accomplish the detailed frequency analysis of the example, the original recording of this song and the frequency calibration tape were re-recorded by reproducing them from a recorder operating at 7.5 ips into another operating at 60 ips. Eighth-speed oscillograph tracings were then prepared by reproducing the copies of the song and the frequency calibration tape at 15 ips. By the use of a frequency calibration curve similar to that reproduced in figure 3, the frequencies of the tones of the notes were determined at a suitable number of critical points on the eighth-speed oscillograph tracing. The elapsed time between the beginning of the first note and each of the critical points was determined by linear measurements on the oscillograph chart. The time represented by the total linear length of the tracing of the song was calculated from the half-speed tracing by making use of the time calibration tracing prepared simultaneously with it. The time represented by each critical point was then calculated by means of the following equation:

$$\text{Time from beginning of song to each critical point (sec.)} = \frac{\text{Linear distance from beginning of song to critical point (mm.)}}{\text{Linear distance from beginning to end of song (mm.)}} \times \text{Length of song as determined from half-speed tracing (sec.)}$$

The data obtained by the detailed frequency-time analysis of the example of pattern 1 were used to prepare figure 6. The vertical axis represents frequency in kilocycles per second (kc) on a logarithmic scale. The horizontal axis represents time in seconds on a linear scale. The pitch of the notes comprising this song varies from 2150 to 7300 cps. The gap between the beginning of the song (zero time) and the beginning of the first note as represented in figure 5 results from the fact that during the bird's attack on this note the structure of the sound was so complex that the pitch could not be resolved. Attention is called also to the structure of the trill which occurs in the middle of the song. Because it contains too many notes to depict it accurately on the scale at which figure 5 was drawn, it was necessary to show it in a symbolic fashion. However, the symbolism shows the nature of the structure of the trill—a series of very short notes on alternately higher and lower frequencies. In the figure the higher line of notes is at the highest pitch found in the trill and the lower line is at the lowest pitch.

The pattern 1 song can be divided into three parts. Part 1 is that portion occurring before the trill. It is difficult to describe except in general terms: a non-repetitive sequence of notes the pitch of which varies over a wide range of frequencies. The trill separates part 1 from part 3, which is a repetitive series of pairs of notes designated couplets. Whereas the first and second parts of the pattern were invariable throughout the series of 22 songs, the number of couplets in part 3 varied from 4 to 6.

The three-part structure of the pattern 1 song is common to all the patterns of Bewick Wren songs recorded and analyzed by the author. It is particularly striking that the repetitive, couplet construction of part 3 has been observed to occur in all of them. However, the detailed nature of the couplets varies from one pattern to another. Part 3 is the loudest part of the song and consequently has the greatest carrying power in the field. It is the field mark by which the song of the Bewick Wren is identified by the author, not only because it is often the only part heard but also because of its distinctive nature. To the ear the couplets sound like single notes and have an assertive, emphatic quality which can be attributed, at least in part, to their double structure.

Measurements were made of the lengths of the 22 pattern 1 songs and of the inter-

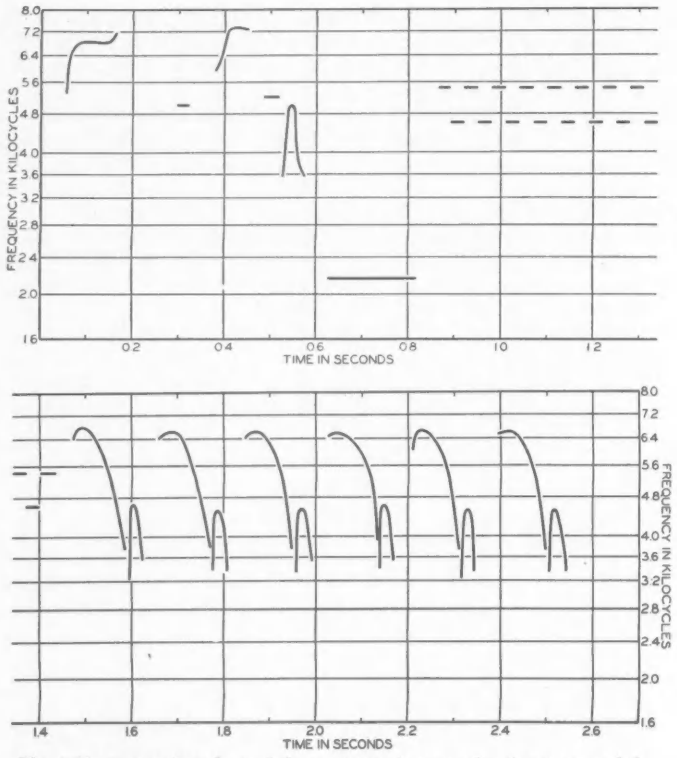

Fig. 6. Frequency-time chart of the representative example of pattern 1 of the Bewick Wren song.

vals between the songs. As described earlier, the half-speed tracings were used in conjunction with the time calibration tracing. Measurements to the nearest 0.01 second can be made by this method. Table 1 summarizes the data on the lengths of the songs. It is apparent from these values that the greatest contribution to the variation in length of the songs arises from the number of couplets present in the song. The average length of the intervals between the songs was 4.48±1.45 seconds. The magnitude of the standard deviation, compared with those calculated for the lengths of the songs, indicates a much greater variation in the length of the intervals, which ranged from 2.98 to 8.80 seconds. From the values for the average length of the songs and for the average length of the intervals the average singing rate was calculated to be 8.7 songs per minute.

Table 1

Lengths of Pattern 1 Songs

	Range (sec.)	Average (sec.)
All songs (22)	2.04–2.57	2.39±0.15
2 Songs containing 4 couplets	2.04–2.13	2.08
7 Songs containing 5 couplets	2.13–2.40	2.30±0.09
13 Songs containing 6 couplets	2.41–2.57	2.49±0.05

SUMMARY

By the use of an assembly of commercially available instruments a new method for the objective study of bird song is provided. Bird songs recorded on magnetic tape are reproduced into a frequency meter and inked oscillograph tracings are obtained by means of a direct inking magnetic oscillograph. The operation and calibration of the equipment and the interpretation of the tracings are discussed. The method is illustrated by the analysis of 22 recorded songs of the Bewick Wren. This analysis shows that all the songs are of the same pattern, a typical specimen of which is depicted in a plot of frequency and time data. The three-part structure of the pattern is discussed and average values presented for the lengths of the songs, the lengths of the intervals between songs, and the singing rate.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the assistance and encouragement given so generously by Mrs. Frances F. Roberts and Mr. Ed N. Harrison. He also thanks innumerable of his colleagues at the Naval Ordnance Test Station, China Lake, California, who have given advice and assistance in the solution of technical problems.

China Lake, California, February 27, 1953.

AN ECOLOGIC ANALYSIS OF THREE CALIFORNIA AVIFAUNAS

By GEORGE WILLIAM SALT

One facet of ecology is the study of the adaptations and adjustments which exist between animals and the environmental conditions surrounding them. Studies of such adjustments are made in the laboratory by placing an animal under a particular set of conditions and measuring its response when a condition is changed. Similar studies of adaptation can be made in the field on either a single species or an entire fauna. Here, variation in environmental conditions may be studied in two ways: one may remain in a single area centering attention on adjustments made by animals to the seasonal changes in the environment, or one may study several areas at the same season each having different environmental conditions and compare the responses of the animals.

To make such field studies of adaptation in birds, one requires a method of analyzing the composition of an avifauna which applies at all seasons of the year (this rules out analyses based on some aspect of breeding behavior) and which will permit comparison between avifaunas having differing species composition. The feeding habits and the foods taken provide a basis for such an analysis. The method of analysis described in this paper, while technically original, is derived from similar systems and concepts used by many workers. Particular acknowledgement should be made to the writings of Colquhoun and Morley (1943), Moreau (1948), and Smith (1951), and to the teachings of Loye Miller.

The analysis is performed by sorting the members of an avifauna into four major groups based on the feeding station within the habitat where they feed. In order of increasing height off the earth, these are: "ground"; "timber," a term used to include the trunks and larger branches of the trees and shrubs; "foliage," used to include both the leaves and the twigs supporting the leaves; and "air." For purposes of simplicity no distinction is made between feeding stations in shrubs and in trees, nor is any effort made to distinguish between strata of different height within a forest. Additions of this sort are possible where the community structure is complex enough to make them desirable.

Following this initial breakdown, further fractionation is made within three of the groups based on either the type of food taken or the method of foraging. Within the "ground" group the birds are assorted into "seeds," "insects," and "predator" categories. Where a species falls into the food categories depends on which type of item forms a major part (over 50 per cent) of its diet. The compilation of Martin, Zim, and Nelson (1951) was used as an authoritative source on percentage composition of diet in most instances. Since the diet of many species changes with the seasons, the classification of such species must be correspondingly changed. The "timber" group is divided into "searching" and "drilling" birds based on the method of obtaining food, since nearly all birds in this group feed largely on insects, sapsuckers being an exception. The "foliage" birds are divided into three categories: "seed," a term applying not only to birds which feed on nuts and seeds while still on the tree but also to those feeding on buds, ovaries of flowers, and other semi-woody substances; "insects," which applies to birds which feed on insects and also to those taking berries; and "nectar," which includes birds feeding on flower nectar regardless of how they obtain it. The "air" group is not subdivided since all such birds feed on insects. This system classifies the avifauna into nine categories (fig. 1).

The size of each of the nine categories within an avifauna may be registered in two ways. The species present in each category may be counted or the actual number of

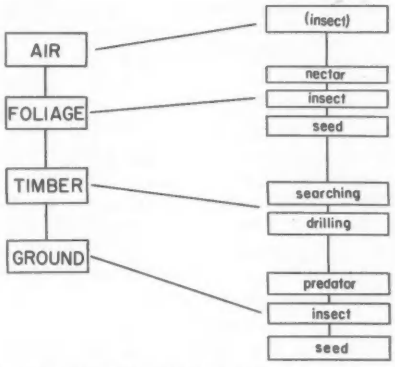

Fig. 1. Diagram of the feeding groups on the left and the nine categories into which they are divided on the right.

individuals, or index thereof, may be determined. Of these two alternatives the latter is somewhat better, as it gives a more accurate representation of the actual avian biomass within each category, but such information is difficult to gather. Both these methods are shown in the analysis for the Yosemite area (fig. 3).

Graphic presentation of the size of each group and subdivision is made by a series of nine bars placed horizontally on a vertical axis and grouped into the four major feeding stations. The width of the bar represents the numerical size of the group. The height of the bar is merely such that the resulting "tree" is properly proportioned. When analysis of the changes in the composition of an avifauna throughout the yearly cycle is made, one such diagram is prepared for the avifauna present in each month. Examination of the feeding habits of the species present must be made for each month and reclassification made for those birds which change their feeding habits with seasonal change in the environment. The resulting series of twelve diagrams forms an "avifaunal spectrum" of the area. When analysis of several areas is to be made for the same time of year, one or several such diagrams for each area are prepared, depending on the length of the season under consideration.

Additional comparison with climatic or other environmental conditions may be obtained by graphing the range of such conditions for each month under the avifaunal diagram. Parallels between changes in environmental conditions and avifauna are thus exposed. If such a complete diagraming is made and is to be compared with another spectrum plus climatic graphs from another region, it is essential that the same scale be used in all diagrams.

Similar diagrams were used during the past year to present to students the avifaunas (breeding birds) of ecologic formations in California as determined by Miller (1951). The birds listed by Miller as "1" and "2" for a formation were used as being those species characteristic of the formation. The species were sorted into the nine categories previously described and were diagrammed with all the "1" species to the left of the vertical axis and all "2" species to the right. The resulting diagrams are highly concentrated summaries of the avifaunas—abstractions upon an abstraction, so to speak.

The three locations used in the present analysis are: Boca Spring, Nevada County, California, visited in 1949, 1950, and 1951 by the author while obtaining birds for experimental work; Yosemite Valley, California, for which were available the data sum-

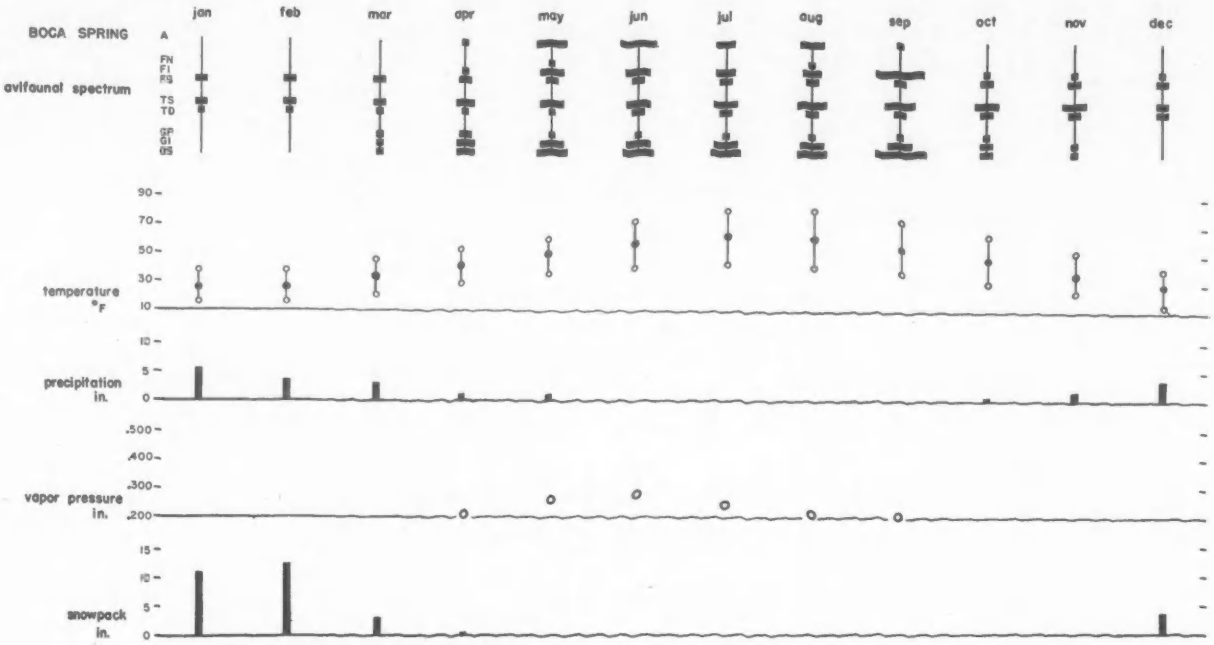

Fig. 2. Avifaunal spectrum and climate diagrams for Boca Spring, Nevada County, California.

marized by Linsdale (1932) from the notes of Mr. and Mrs. Charles W. Michael for the years 1920 to 1931; and Glen Oaks canyon on the outskirts of Glendale, California, visited frequently by the author between 1936 and 1942 in company with William G. Webb and Vincent S. Yoder.

BOCA SPRING, NEVADA COUNTY

Boca Spring is a permanent spring 8½ miles northeast of Truckee at an elevation of 6000 feet on the east slope of the central Sierra Nevada of California. The area studied consists of a meadow approximately one hundred yards long watered by the spring and the xeric pine forest surrounding the meadow. The forest is made up of three vegetational strata. The tree layer is composed of second growth *Pinus jeffreyi*, thirty to sixty feet high, and spaced evenly about ten to thirty yards apart. The shrub layer consists of bushes of three species, *Artemisia tridentata*, *Purshia tridentata*, and *Wyethia mollis*, spaced two to six feet apart. Between these bushes grows a sparse cover of grasses, *Bromus tectorum*, *Poa secunda*, and *Sitanion hystrix*, and forbs not identified. This vegetation represents that of an ecotone between the pine forests of higher elevations and the *Artemisia* covered sagebrush desert of lower elevations. The meadow vegetation consists of a great variety of grasses, sedges, and rushes, some of which are *Juncus balticus*, *J. nevadensis*, *J. effuses*, *Carex kelloggii*, *C. nebraskensis*, and *Mimulus guttatus*. In the running water coursing through the meadow are *Lemna* sp. and *Montia* sp. The entire area studied slopes toward the west.

Climatically Boca Spring is dry, having an annual total precipitation of 21 inches, about half to one-third that of the same elevation on the west slope of the Sierra. Summer temperatures are warm in the daytime, with cool nights and frost possible at practically any time of the year. Snowfall is moderate, being about half that at the same elevation on the Sierran west slope. Winter temperatures tend to be lower, both day and night than on the west slope.

Although no detailed studies of soil were made, the soil appears to be shallow and of poor quality. Rocky outcrops are common over the area, and in eroded ruts in the roads a rocky substrate, composed of boulders ranging from an inch in diameter upward, is revealed only a few inches below the surface. The soil within the meadow is rich and at least a foot deep in the deepest portions. It is, however, saturated with water a greater part of the growing season, and it is frozen solid the rest of the year.

In the fall, birds apparently migrating south along the east slope of the Sierra Nevada pass through Boca Spring, and for a few weeks they swell the avifauna both in total number and in species composition. Winter populations are small and widely scattered. The avifauna increases through the spring to the full size of the breeding population in early summer and drops off in later summer due, it is suspected, to an up-mountain migration of postbreeding birds to the forests and meadows of the Sierran crest where the vegetation is still lush at that season (fig. 2).

Except for November, January, and February, trips were made to this area monthly, usually for three days. Careful surveys and notes were made of the avifauna on each trip. Composition of the bird life of those months when the area was not visited was derived from generalized reports on the bird life of the central Sierra Nevada at those seasons and by interpolation from data obtained in adjacent months.

YOSEMITE VALLEY, YOSEMITE NATIONAL PARK

Yosemite Valley has been visited by so many people and accounts and photographs published so frequently, that a detailed description of it is unnecessary. Accounts of the flora may be found in Hall and Hall (1912). The valley lies in a glacier-carved gouge

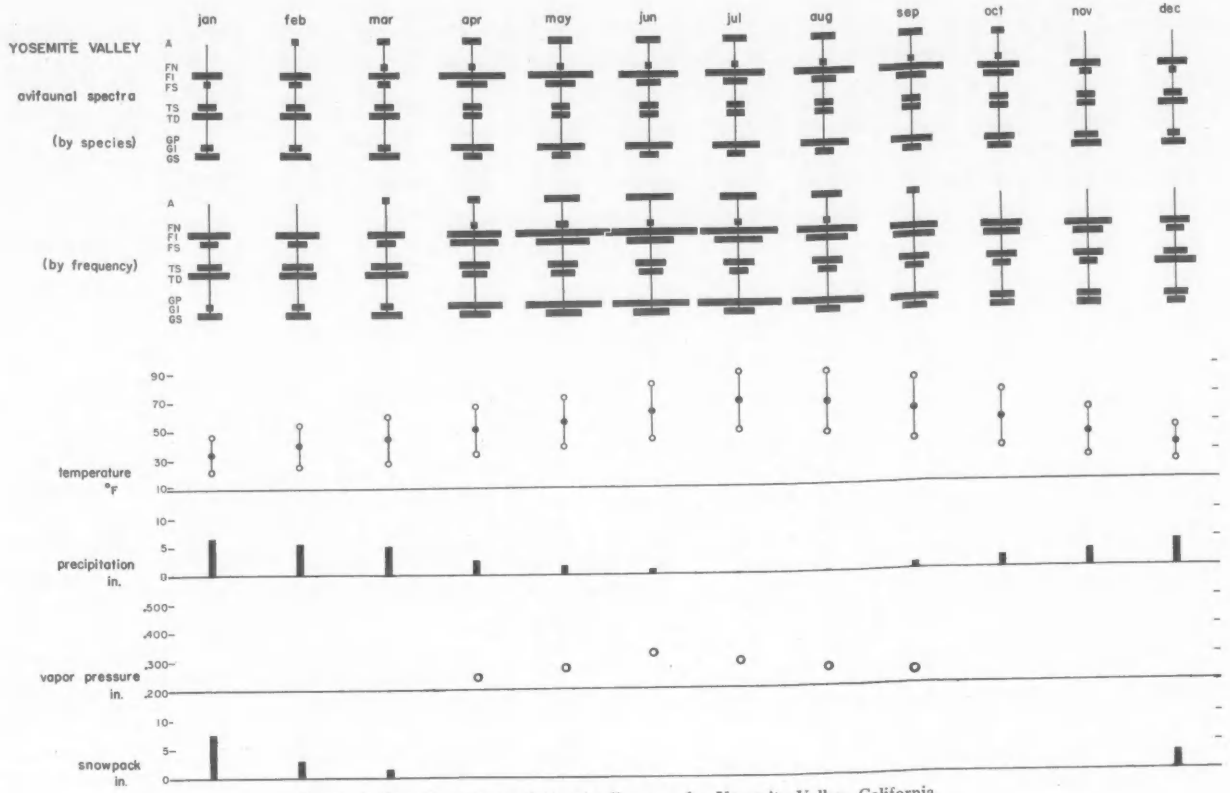

Fig. 3. Avifaunal spectra and climate diagrams for Yosemite Valley, California.

in the west slope of the Sierra Nevada at an elevation of 4000 feet, walled by cliffs and peaks of elevations from 6000 to 9000 feet. The Merced River traverses this valley from east to west.

The flora varies from an open coniferous forest composed of yellow pine (*Pinus ponderosa*), Douglas fir (*Pseudotsuga taxifolia*), incense cedar (*Libocedrus decurrens*), white fir (*Abies concolor*), and black oak (*Quercus kelloggii*) through moist meadows to streamside associations of willows (*Salix* sp.), black cottonwood (*Populus fremontii*), dogwood (*Cornus nuttallii*), and alder (*Alnus rhombifolia*). Golden-cup oak (*Quercus chrysolepis*) is found on the talus slopes along the margins of the narrow valley.

The region has a moderate climate. Days become hot in midsummer, but night temperatures are cool. Winter temperatures are moderately cold, with a light snowfall, which, however, varies widely from one year to the next. The total precipitation averages 33 inches a year. Probably the weather within the valley, bounded as it is on all sides by high walls, is not characteristic of other places on the west slope of the Sierra at the same elevation.

The species composition of the avifauna, by months, was plotted (fig. 3, upper series of diagrams) from the list presented by Linsdale (*op. cit.*, table 1). The diagrams by frequency for each month were made by totaling the frequency values for the month in question for all species of one category. This sum was divided by 50 to the nearest whole number and the quotient used to determine the length of the bar in the diagram (fig. 3, lower series of diagrams). The number 50 was chosen arbitrarily so as to produce horizontal bars within the same value ranges as in the species diagrams.

GLEN OAKS CANYON, GLENDALE, LOS ANGELES COUNTY

Glen Oaks Canyon lies at the eastern edge of the city of Glendale in the coastal chaparral belt of southern California. At the time the data used here were collected it was relatively unaffected by human activities except those of hikers and occasional naturalists. Some small check dams three to six feet high were once installed to retard runoff. To insure that there would be some runoff to retard, the undergrowth had been cleared from the walls of the canyon, but at the time of the visits this had all grown back, the dams had silted in and were almost hidden in leaf mold. The canyon, running from north to south, drained several square miles of chaparral-covered hillside. Water ran in the bottom in a small rivulet during practically the entire year, and it reached creek proportions, four to ten feet wide, during severe rains. At its mouth the canyon opened to form a sandy wash although the water drained into the ground before reaching this spot during most of the year.

Vegetation in the sandy mouth of the canyon consisted of a scattered tree canopy of live oak (*Quercus agrifolia*) and California sycamore (*Platanus racemosa*). There was an interrupted shrub layer of *Ribes speciosum, Stachys bullata, Nicotiana glauca, Solanum douglasii,* and *Sambucus coerulea.* The ground was covered each spring by a growth of annual grasses which gave way during the summer to scattered composites such as *Senecio vulgaris.*

Upstream from its mouth the canyon narrowed and become steep walled. The tree layer made a continuous canopy of sycamore and live oaks, mostly the latter, now changed in habit from a wide-crowned form into tall slender trees carrying leaves only on the upper branches. There were, in addition, cottonwoods (*Populus fremontii*) and laurel (*Umbellularia californica*) growing along the bottom of the canyon. The understory consisted of poison oak (*Rhus diversiloba*), *Rubus vitifolia,* ferns, *Equisetum,* and numerous annual forbs and grasses. Much of the ground surface carried no lower vegetation, but a layer of leaves and leaf mold covered the decomposing granite soil.

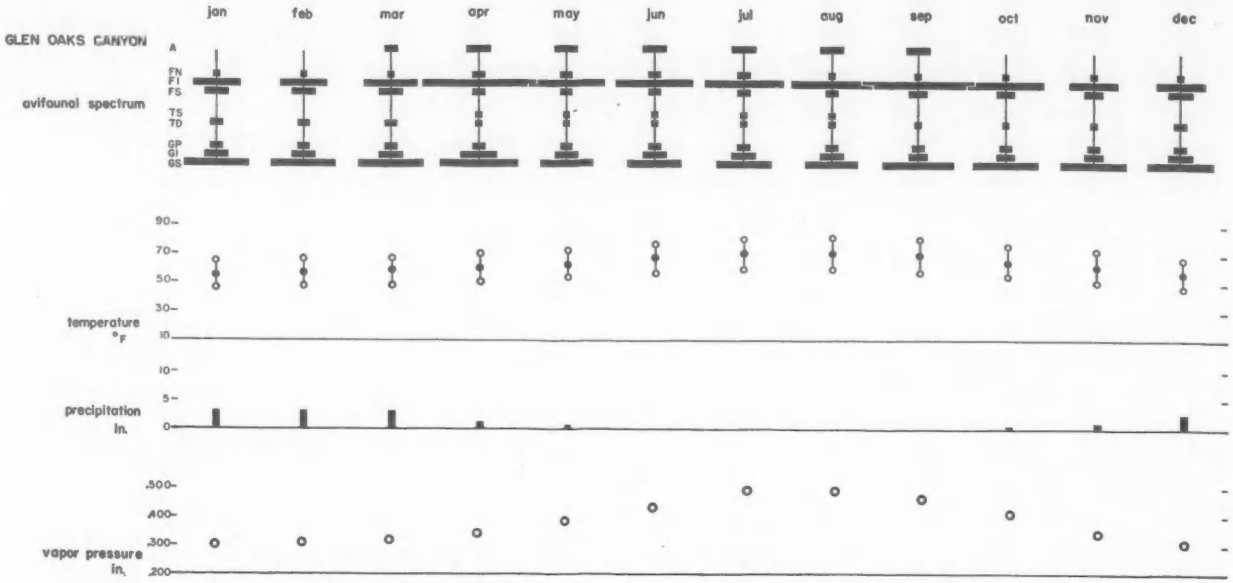

Fig. 4. Avifaunal spectrum and climate diagrams for Glen Oaks Canyon, Los Angeles County, California.

The adjacent hills were covered with coastal chaparral with all its usual elements such as *Adenostoma, Artemisia, Rhus, Rhamnus, Ceonothus,* and *Salvia.*

The climate is typical of coastal southern California. Winters are moderately warm, frosts being few and absent in some winters; summers are warm to hot; and the diurnal range from night to daytime temperatures is small at all seasons. The vapor pressure of water in the air is moderate in winter and high in late summer, but rainfall is light, with 15 inches annual average, and subject to considerable annual variation.

The avifauna of Glen Oaks canyon is made of three elements: a resident population, a summer visitant population, and a winter visitant population. These are of approximately the same size so that there is no dramatic change in the number of birds present at any one period although the species composition changes with the seasons. The summer population is somewhat higher than at other times of year (fig. 4).

Notes on the avifauna were kept through several years of frequent but irregular visiting. During 1941 an intensive study of the biota was conducted with surveys of the bird population being made on bi-weekly visits throughout the year.

DISCUSSION

Feeding is used as the basis for this study method because it is considered to be of major importance in the lives of birds and most other avian activities are subject to modification or variation as necessary to meet food demands successfully. Kendeigh (1949) and Siebert (1949) demonstrated that response to winter temperatures is governed by food intake ability. Lack (1950), Skutch (1950), Moreau (1950), and Voous (1950) report that breeding seasons of birds in various parts of the world are closely correlated with the appearance of abundant food. Furthermore, the breeding season is not the same for feeders of all types in a given area, but birds appear to breed in the most favorable feeding season often despite unfavorable climatic conditions. Errington (1941) and Cade (1952) correlate density of a species of birds with the available food in addition to other factors such as cover and roosting places. Moreau (1950) reports that breeding may be prevented or interrupted by a failure of the food supply. Lack (1947) concludes that clutch size in various species of birds is genetically determined in relation to the food available for feeding young during the breeding season. Kendeigh and Baldwin (1937) suggest, from work by Kleiber and Dougherty (1934), that unfavorable combinations of climate and a depressing influence thereof upon food intake may result in a lack of egg production in house wrens (*Troglodytes aëdon*).

It is self evident that the distribution of specialized feeders such as woodpeckers, crossbills, and hummingbirds is determined by feeding sites and food in addition to other factors such as climate and nesting sites. In other species, food considerations probably are equally significant, although less obvious without detailed study. In a study of three finches of the genus *Carpodacus* (Salt, 1952) it appeared that interaction of climatic conditions and feeding were of major importance in regulating the summer distribution of all three species, but particularly *C. purpureus* and *C. cassinii.*

A classification of birds by feeding habits shows a similarity to familial classification. Within certain families, such as the Tyrannidae, Sittidae, and Troglodytidae, feeding behavior is fairly constant, and a classification according to family is equivalent to one according to food habits. In other families, however, such as the Falconidae, Picidae, and Fringillidae, birds of diverse feeding and ecologic type are brought together taxonomically but such a grouping does not apply ecologically. Furthermore, if faunal classification were made on the basis of family groups the opportunity for comparing avifaunas from widely separated land masses would be lost. If one used such a system he would be unable, for instance, to compare the birds of the open savanna of central

Africa and its large numbers of ploceids with the avifauna of the savannas in California where no birds of this family occur except the introduced English Sparrow.

Habitat selection, the strictly psychological response by birds to the aspect of vegetation, appears to operate strongly only during the breeding season, and for this reason it will not serve as a basis for codification of ecologic preferences throughout the year. Biomes, life-zones, and biotic provinces, the major ecologic units currently used for ecologic classification, are too wide in their scope to provide any but a gross correlation between birds and their environments. Studies of bird fauna in successional stages of a particular biome provide excellent correlation between avian occurrence and vegetational characteristics but do not allow comparison between avifaunas of different geographic regions.

The nine categories used here appear to be the best choice as of this time. Further use may make changes desirable. It may be advisable to divide the "air" group into a "flying" category for the swallows and nighthawks, and a "perching" category for the flycatchers. Also, it may be more valuable to divide the birds that feed in the tree foliage from those feeding in the shrub layer. This change would require the addition of three more layers in the diagrams. For simplicity both these alternatives were rejected in this initial report; they could always be adopted if required. Basically, the choice is between a highly specific classification and a generalized one. The one here proposed is moderately generalized. Within each category the birds presumably segregate into their respective niches on the basis of size of food particles eaten, stratum within the major elevation from the ground where they feed (Colquhoun and Morley, 1943), degree of adherence to specific diet of one type, and psychological preference for a specific location. None of these subtler characteristics are revealed in this classification.

Inspection of the spectrum of a single locality for an entire year reveals that between certain months no great change in the avifauna takes place. It may prove to be convenient and to sacrifice no great degree of accuracy to group the similar months together and express their fauna by a single diagram while graphing individually those months wherein important changes take place. Thus December-January-February and June-July-August might each be expressed with a single graph and the remaining months shown individually, a reduction from twelve to eight individual figures in the spectrum.

This system of classifying field observations provides a tool for certain kinds of studies not possible with other approaches. Generalized comparisons can be made between avifaunas on an ecologic basis regardless of the taxonomic character of those avifaunas. It will permit the charting of variation in faunal structure with changes in environment due to plant succession, seasonal change, or land management manipulation. Reversing this approach, the avifauna may be regarded as a reflection of the structure and character of the environment and used to trace variation therein. Grinnell was right in regarding animals as more sensitive to the environment than any thermometer or atmometer (quoted in Allee, *et al.*, 1949:56). What apparently never occurred to him was the fact that without twenty-five years of intimate acquaintance with those animals, such as he had, you could not read this "thermometer," or if you could, you could not communicate your reading to anyone else. This type of classification also serves to throw into focus probable relationships between specific environmental conditions such as climate, vegetation, and structure and the birds living in that area.

Classifying thus, however, is a specialized approach and while exposing information of one sort it also ignores or actually conceals information of other kinds. Specific ecologic requirements of a single species are not elucidated save in a general way. Evolutionary adherence to a specific landmass or to a migrating flora is not revealed. Placing a bird in a specific food category because it eats more than 50 per cent of foods of a

certain kind serves to conceal the character of the remainder of its diet. These secondary foods may be highly significant not only in governing ecologic response but also nutritionally. This is, of course, a "one factor" analysis and as such, subject to "over-implification," to coin a word.

RESULTS

Critical comparison of the spectra (figs. 2–4) for the three localities reveals many informative differences between them, not only in the presence or absence of categories at a particular season but changes of size within, and changes of proportion between, categories with the seasons. Not all these points require enumeration, but some of the more interesting merit comment.

Considering the Boca avifauna first, within the foliage group the nectar feeding birds are absent as residents and appear in the spectrum only as transients during the spring and early fall. This presumably is a reflection not of a complete lack of nectar producing flowers but of low density of them, insufficient to permit efficient harvesting of nectar by a bird confined to a limited area during the nesting period. In the ground group, winter conditions of low temperatures, especially at night, coupled with the deep snowpack serve to eliminate this stratum as a forage area during the three winter months, but ground foraging is resumed in the spring well before all the snow is melted. Ground foraging is about equally divided between insects and seeds throughout the season except in the fall when the large influx of migrant insect eaters arrives.

In the Yosemite avifauna, insect-eating birds of the foliage group are the dominant category whether listed by species or by frequency of observation of species, and more so in winter than in summer. This high winter proportion is explained by the fact that many of them at that season are actually eating berries rather than insects. Also there is an obvious rise in the foliage-insect category (by frequency) during the spring migration but not in the fall migration. In the timber group the searching birds are the constant element throughout the season. Comparison with the other diagrams reveals that such is not the case at the other two localities. In the ground group, the lack of predators is probably due to the area being a national park with a heavy human population during much of the year. It will also be noted that winter conditions in Yosemite are less effective than at Boca in modifying ground foraging, especially for the seed eaters which are practically constant both in numbers of species and frequency throughout the year.

In the avifauna of Glen Oaks both the foliage and ground groups are large. The foliage group is dominated throughout the year, but particularly in summer, by the insect eaters. There is a large influx of birds of this category to the area during both the spring and fall migrations. The seed eaters in this group feed mostly on acorns and form an important part of the foliage group only during the winter. The timber group is very poorly represented, particularly by timber searchers. Whether this is due to the characteristics of oaks and sycamores in providing foraging niches or to a different insect population is unknown. The ground foraging group is largely composed of seed eaters, more so in winter than in summer. The dry and stony ground apparently provides a poor supply of insects compared to the seed crop. This ground environment is essentially stable throughout the year, both in numbers and proportions of the three categories to one another.

The following comments are prompted by comparison of the three spectra. Boca is essentially a harsh and unproductive environment. Low winter temperatures, an appreciable snowpack, high summer temperatures, dry air, and poor soil combine to yield a limited food supply. This supply is exploited to the fullest in the summer, but supports

only a meager bird life in the winter. The avifauna as here diagramed is essentially in good proportion throughout the year. Comparing the diagrams for July for all three localities will demonstrate this conclusion. Proportionality is maintained throughout the march of the seasons, the birds of all groups gradually diminishing at equal rates with the onset of winter.

The Yosemite avifauna also shows balanced proportions between groups and within each group. Major fluctuations result from changes in the population of insect eating birds. Presumably the varied avifauna results from a high variety of niches and good production of foods. This is to be expected from the moderate winter conditions, warm moist summer, and variety in the vegetation.

In the Glen Oaks area the avifauna is not well proportioned between the groups. The foliage and ground groups are much larger than the others, the air group is moderate, and the timber groups very small. Further, within the foliage and ground groups, one category is much larger than the others, particularly so in the foliage groups where the category of insect eaters is large compared to the others. This suggests either extreme conditions, or what may be another way of regarding the same circumstances, lack of variety. Weather conditions are without variety. Temperatures vary only slightly from winter to summer, and there is little spread at any season from maximum to minimum temperatures. Rainfall is slight in winter; partly compensating for the lack of summer rains is a high vapor pressure during that period producing relatively uniform conditions of moderate aridity throughout the year. Vegetation conditions also show only moderate change with the seasons. The oaks are not deciduous and many of the shrubs of the region are in leaf throughout the year. Only the grasses show a pronounced seasonal variation.

There is less difference between the localities in their air feeding birds than in any other group. The response of this group to seasonal change is nearly the same both with respect to time of arrival and departure and in numbers of species for all the three localities despite the many differences in climate and vegetation between them. Apparently birds of this feeding habit are little influenced by these two important features of the environment, which is another way of saying that in any locality there will be found about the same variation in the composition of the flying insect population.

Insectivorous birds are the most sensitive to changes in season and vegetation. The upsurge in insect eaters both in the foliage and on the ground, but not in the air, comes in the spring after the first noticeable decrease in rainfall. That is to say, these birds arrive in an area in the first dry month following the spring rains. This tendency can be seen in the spectra for all three localities. Whether there is a direct causal relation between these two events cannot be said, but it is worth noting that in the fall, when the rainfall changes gradually instead of by steps as in the spring, there is a corresponding gradual change in the insect-eating population rather than a sudden one.

In the seed-eating birds of the foliage group, the Boca population is small and constant throughout the year, the Yosemite population is highest in the summer, and the Glen Oaks population is highest in the winter. This suggests that Yosemite and Glen Oaks or similar stations are serving as summer and winter quarters for a certain portion of the seed-eating birds. Whether this actually is true or not depends on whether the decreases and increases registered represent actual departures from the areas or merely changes in food habits of birds present all year round.

The presence of a noticeable spring migration through Yosemite and a noticeable fall migration through Boca once more brings to mind the possibility of a change in the migration route up and down the Sierran axis from spring to summer. Field observations

by others have also suggested this possibility, but so far no definite answer is possible without banding data.

Comparison of the three avifaunas and their changes throughout the year reveals this fact. Yosemite and Glen Oaks have a large and stable population throughout the year. This population is augmented in summer at Yosemite by the addition, largely, of insect eating birds in the air, foliage, and ground groups. In Glen Oaks the basic structure of the avifauna is even more stable .In summer there are added the insect-eating birds in the air and foliage groups and in winter the seed-eating birds in the foliage and ground groups. In both localities at least half the feeding niches are, so to speak, open for occupancy the year round. Under the conditions of climate and vegetation present in the two areas these niches will sustain the birds occupying them through the environmental stresses presented in the course of a year. The other niches are open for use during more limited portions of the winter or summer.

At Boca, on the other hand, the entire structure of the avifauna is drastically modified by the seasonal march of environmental conditions. There is only a small population of hardy species to be considered as the basic one of the area. Sooner or later, as winter conditions become more severe, practically all the niches are closed to further use by birds and they are forced to leave.

Whether the difference in pattern between Boca and the other two places is due merely to differences in elevation or is a more general distinction between the habitats of the Pacific slope and the Great Basin may be revealed by further analyses of the type here presented.

SUMMARY

A method is described for classifying the avifauna of a locality into nine categories on the basis of location of the feeding site within the strata of the vegetation and the type of food taken. A diagram of horizontal bars on a vertical axis is used to graph the results of such classification.

Yearly changes in the bird life of three Californian localities are reported and diagramed according to this system. These are: Boca Spring, Nevada County; Yosemite Valley; and Glen Oaks Canyon, Los Angeles County.

Birds of certain feeding habits, such as the air feeders, show little sensitivity to differences in environmental conditions from place to place, while other feeding types appear to be extremely sensitive, particularly those feeding on insects either in the foliage or on the ground.

Differences between these localities are revealed in the structure and proportions of their avifaunas. Presumably these differences reflect differences in vegetation structure and climate.

Both Yosemite Valley and Glen Oaks Canyon provide a sizeable proportion of niches available for use throughout the entire year, while at Boca Spring nearly all the niches are closed to use during the winter months.

AVIFAUNA OF BOCA SPRING

Species	Residence	Classification
Accipiter striatus, Sharp-shinned Hawk	Apr.	ground-predator[1]
Buteo jamaicensis, Red-tailed Hawk	Mar.–Oct.	ground-predator
Falco sparverius, Sparrow Hawk	Apr.–Sept.	ground-insect
Zenaidura macroura, Mourning Dove	Apr.–Sept.	ground-seed
Chordeiles minor, Booming Nighthawk	Aug.–Sept.	air
Phalaenoptilus nuttallii, Poor-will	May–Aug.	air
Selasphorus rufus, Rufous Hummingbird	May, Aug.	foliage-nectar
Colaptes cafer, Red-shafted Flicker	May–Oct.	ground-insect
Dendrocopos villosus, Hairy Woodpecker	All year .	timber-drilling

AVIFAUNA OF BOCA SPRING *(continued)*

Species	Residence	Classification
Dendrocopos albolarvatus, White-headed Woodpecker	June–Dec.	timber-drilling
Empidonax wrightii, Wright Flycatcher	May–June	air
Empidonax griseus, Gray Flycatcher	May–Aug.	air
Contopus richardsonii, Western Wood Peewee	May–Aug.	air
Tachycineta thalassina, Violet-green Swallow	Apr.–June	air
Cyanocitta stelleri, Steller Jay	All year	foliage-seed
Nucifraga columbiana, Clark Nutcracker	Apr.–Nov.	foliage-seed
Parus gambeli, Mountain Chickadee	All year	timber-searching
Sitta carolinensis, White-breasted Nuthatch	May–Nov.	timber-searching
Sitta canadensis, Red-breasted Nuthatch	Aug.–Sept.	timber-searching
Sitta pygmaea, Pigmy Nuthatch	Apr.–Nov.	timber-searching
Certhia familiaris, Brown Creeper	All year	timber-searching
Turdus migratorius, Robin	Apr.–Sept.	ground-insect
Sialia currucoides, Mountain Bluebird	Mar.–Nov.	ground-insect
Myadestes townsendi, Townsend Solitaire	May–Dec.	foliage-insect
Regulus calendula, Ruby-crowned Kinglet	Sept.	foliage-insect
Vireo solitarius, Solitary Vireo	Sept.	foliage-insect
Vireo gilvus, Warbling Vireo	Sept.	foliage-insect
Vermivora celata, Orange-crowned Warbler	May, Sept.	foliage-insect
Dendroica auduboni, Audubon Warbler	Apr.–Sept.	foliage-insect
Dendroica occidentalis, Hermit Warbler	Sept.	foliage-insect
Wilsonia pusilla, Pileolated Warbler	May–June	foliage-insect
Piranga ludoviciana, Western Tanager	June–Sept.	foliage-insect
Carpodacus cassinii, Cassin Finch	All year	foliage-seed Dec.–Mar. ground-seed Apr.–Nov.
Chlorura chlorura, Green-tailed Towhee	May–Sept.	ground-seed
Pipilo erythrophthalmus, Spotted Towhee	Sept.	ground-seed
Junco oreganus, Oregon Junco	Mar.–Oct.	ground-seed
Spizella passerina, Chipping Sparrow	May–Sept.	ground-insect[2]
Zonotrichia leucophrys, White-crowned Sparrow	Sept.	ground-seed
Melospiza melodia, Song Sparrow	Aug.–Sept.	ground-seed

[1] A debatable classification. Many persons would classify this species as a foliage predator, but in this situation they take an important percentage of prey on the ground. Precisely what percentage cannot be determined.
[2] From April through August the diet of this species is over 50 per cent insects. In September the percentage of plant food taken is over 50 per cent (see Martin, Zim, and Nelson, 1951:202)

AVIFAUNA OF YOSEMITE VALLEY

Species	Residence	Classification
Falco sparverius, Sparrow Hawk	All year	ground-insect
Actitis macularia, Spotted Sandpiper	Apr.–Sept.	ground-insect
Columba fasciata, Band-tailed Pigeon	All year	foliage-seed Apr.–Oct. ground-seed Nov.–Mar.
Aëronautes saxatalis, White-throated Swift	Feb.–Oct.	air
Stellula calliope, Calliope Hummingbird	Mar.–Oct.	foliage-nectar
Colaptes cafer, Red-shafted Flicker	All year	ground-insect Apr.–Nov. timber-drilling Dec.–Mar.
Balanosphyra formicivora, Acorn Woodpecker	All year	foliage-seed Apr.–Nov. timber-drilling Dec.–Mar.
Dendrocopos villosus, Hairy Woodpecker	All year	timber-drilling
Dendrocopos pubescens, Downy Woodpecker	All year	timber-drilling
Dendrocopos albolarvatus, White-headed Woodpecker	All year	timber-drilling
Empidonax traillii, Traill Flycatcher	May–Oct.	air
Contopus richardsonii, Western Wood Peewee	Apr.–Sept.	air
Tachycineta thalassina, Violet-green Swallow	Mar.–Sept.	air
Cyanocitta stelleri, Steller Jay	All year	foliage-seed
Parus gambeli, Mountain Chickadee	All year	timber-searching
Sitta canadensis, Red-breasted Nuthatch	All year	timber-searching

AVIFAUNA OF YOSEMITE VALLEY *(continued)*

Species	Residence	Classification
Certhia familiaris, Brown Creeper	All year	timber-searching
Catherpes mexicanus, Canyon Wren	All year	ground-insect
Turdus migratorius, Robin	All year	foliage-insect Sept.–Mar. ground-insect Apr.–Aug.
Hylocichla ustulata, Swainson Thrush	May–Nov.	ground-insect
Sialia mexicana, Mexican Bluebird	Oct.–May	foliage-insect[1]
Regulus satrapa, Golden-crowned Kinglet	All year	foliage-insect
Regulus calendula, Ruby-crowned Kinglet	Sept.–May	foliage-insect
Vireo solitarius, Solitary Vireo	Apr.–Sept.	foliage-insect
Vireo gilvus, Warbling Vireo	Apr.–Sept.	foliage-insect
Dendroica aestiva, Yellow Warbler	Apr.–Sept.	foliage-insect
Dendroica audubóni, Audubon Warbler	All year	foliage-insect
Dendroica nigrescens, Black-throated Gray Warbler	Apr.–Oct.	foliage-insect
Oporornis tolmiei, Tolmie Warbler	Apr.–Sept.	foliage-insect
Agelaius phoeniceus, Red-winged Blackbird	Feb.–Oct.	ground-seed
Euphagus cyanocephalus, Brewer Blackbird	Apr.–Nov.	ground-insect Apr.–Sept. ground-seed Oct.–Nov.
Piranga ludoviciana, Western Tanager	Apr.–Sept.	foliage-insect
Pheucticus melanocephalus, Black-headed Grosbeak	Apr.–Oct.	foliage-insect[2]
Hesperophona vespertina, Evening Grosbeak	Feb.–Oct.	foliage-seed Feb.–May, Sept.–Oct. foliage-insect June–Aug.
Carpodacus purpureus, Purple Finch	All year	foliage-seed Apr.–Oct. ground-seed Nov.–Mar.
Pipilo erythrophthalmus, Spotted Towhee	All year	ground-seed
Junco oreganus, Oregon Junco	All year	ground-seed
Spizella passerina, Chipping Sparrow	Apr.–Sept.	ground-insect[3]

[1] Mistletoe berries gathered in the trees form the major food for this species in Yosemite in winter (Grinnell and Storer, 1924:620).

[2] Classified as foliage insect since their diet consists mostly of insects and some berries (Martin, Zim, and Nelson, 1951:180).

[3] See note 2, p. 270.

AVIFAUNA OF GLEN OAKS CANYON

Species	Residence	Classification
Accipiter cooperii, Cooper Hawk	All year	ground-predator[1]
Buteo jamaicensis, Red-tailed Hawk	All year	ground-predator
Lophortyx californica, California Quail	All year	ground-seed
Columba fasciata, Band-tailed Pigeon	Dec.–Mar.	foliage-seed
Zenaidura macroura, Mourning Dove	All year	ground-seed
Otus asio, Screech Owl	All year	ground-insect
Archilochus alexandri, Black-chinned Hummingbird	Apr.–July	foliage-nectar
Calypte anna, Anna Hummingbird	All year	foliage-nectar
Colaptes cafer, Red-shafted Flicker	All year	ground-insect Mar.–Aug. timber-drilling Sept.–Feb.
Balanosphyra formicivora, Acorn Woodpecker	All year	foliage-seed Apr.–Nov. timber-drilling Dec.–Mar.
Dendrocopos nuttallii, Nuttall Woodpecker	All year	timber-drilling
Myiarchus cinerascens, Ash-throated Flycatcher	Apr.–Sept.	air
Empidonax difficilis, Western Flycatcher	Mar.–Sept.	air
Contopus richardsonii, Western Wood Pewee	Apr.–Sept.	air
Petrochelidon pyrrhonota, Cliff Swallow	Mar.–Sept.	air
Cyanocitta stelleri, Steller Jay	Dec.–Mar.	foliage-seed
Aphelocoma coerulescens, Scrub Jay	All year	foliage-seed
Parus inornatus, Plain Titmouse	All year	timber-searching Apr.–Aug. foliage-seed Sept.–Mar.
Psaltriparus minimus, Bush-tit	All year	foliage-insect
Chamaea fasciata, Wren-tit	All year	foliage-insect
Troglodytes aëdon, House Wren	Mar.–Oct.	foliage-insect

AVIFAUNA OF GLEN OAKS CANYON *(continued)*

Species	Residence	Classification
Thryomanes bewickii, Bewick Wren	All year	foliage-insect
Toxostoma redivivum, California Thrasher	All year	ground-insect
Hylocichla guttata, Hermit Thrush	Oct.–Apr.	ground-insect
Hylocichla ustulata, Swainson Thrush	Apr.–Sept.	ground-insect
Sialia mexicana, Mexican Bluebird	Dec.–Apr.	ground-insect
Polioptila caerulea, Blue-gray Gnatcatcher	All year	foliage-insect
Regulus calendula, Ruby-crowned Kinglet	Oct.–Mar.	foliage-insect
Phainopepla nitens, Phainopepla	Apr.–Sept.	foliage-insect[2]
Vireo huttoni, Hutton Vireo	All year	foliage-insect
Vireo bellii, Bell Vireo	Apr.–Sept.	foliage-insect
Vireo solitarius, Solitary Vireo	Apr., Sept.–Oct.	foliage-insect
Vireo gilvus, Warbling Vireo	Apr.–Oct.	foliage-insect
Vermivora celata, Orange-crowned Warbler	Mar., Sept.	foliage-insect
Dendroica aestiva, Yellow Warbler	Apr.–Sept.	foliage-insect
Dendroica auduboni, Audubon Warbler	Sept.–Apr.	foliage-insect
Dendroica nigrescens, Black-throated Gray Warbler	Apr., Sept.	foliage-insect
Dendroica townsendi, Townsend Warbler	Apr., Oct.	foliage-insect
Dendroica occidentalis, Hermit Warbler	Apr., Aug.	foliage-insect
Wilsonia pusilla, Pileolated Warbler	Apr.–Oct.	foliage-insect
Icterus cucullatus, Hooded Oriole	Apr.–Sept.	foliage-insect
Piranga ludoviciana, Western Tanager	Apr., Sept.	foliage-insect
Pheucticus melanocephalus, Black-headed Grosbeak	Apr.–Sept.	foliage-insect
Passerina amoena, Lazuli Bunting	Apr.–Sept.	ground-seed
Carpodacus mexicanus, House Finch	All year	ground-seed
Spinus psaltria, Arkansas Goldfinch	All year	ground-seed
Spinus lawrencei, Lawrence Goldfinch	Apr.–Sept.	ground-seed
Pipilo erythrophthalmus, Spotted Towee	All year	ground-seed
Pipilo fuscus, Brown Towhee	All year	ground-seed
Junco oreganus, Oregon Junco	Oct.–Apr.	ground-seed
Spizella passerina, Chipping Sparrow	Apr., Sept.	ground-seed (Sept.) ground-insect (April)
Zonotrichia coronata, Golden-crowned Sparrow	Sept.–Apr.	ground-seed
Zonotrichia leucophrys, White-crowned Sparrow	Sept.–Apr.	ground-seed
Passerella iliaca, Fox Sparrow	Oct.–Apr.	ground-seed
Melospiza melodia, Song Sparrow	All year	ground-seed

[1] This classification is open to debate. The exact percentage of prey taken on the ground cannot be stated.
[2] Classified thus instead of "air" on the basis of data from Martin, Zim, and Nelson (page 159) and personal observations that in this area they depend heavily on berries of *Sambucus* for food supply.

WEATHER DATA

Glen Oaks Canyon. All data are for Los Angeles from the United States Department of Agriculture Weather Bureau; see "Climatic Summaries by Sections to 1930" (Section 18). Vapor pressure data are taken from Day (1917). Vapor pressure is that for 5:00 p.m., Pacific Standard Time.

Yosemite Valley. All data are from "Climatic Summaries by Sections to 1930" (Section 17), except snowpack and vapor pressure data. Snowpack figures were derived by averaging monthly records for the years from 1937 to 1948 published by the United States Department of Commerce in "Climatological Data, Monthly Summaries, California Section." Vapor pressure figures are for South Entrance (Yosemite) Ranger Station, elevation 5120 feet, at 4:30 p.m., Pacific Standard Time, from 1938 to 1948 (data provided by Fire Weather Section of Weather Bureau at San Bruno, California).

Boca Spring. Mean temperature based on a 30-year record is for Boca from McAdie (1903). Maximum and minimum temperatures are for Truckee from "Climatic Summaries by Sections to 1930" (Section 16). Precipitation figures are for Boca, also from the Climatic Summaries. Snowpack figures are for Boca averaged from monthly records in climatological data of the United States Department of Commerce from 1937 to 1948. Vapor pressure figures are for Sierraville, elevation 5000 feet, 20 miles northwest of Boca, at 4:30 p.m., Pacific Standard Time, for the years from 1938 to 1948; these data were provided by the Fire Weather Section of the Weather Bureau at San Bruno, California.

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Department of Zoology, University of California, Davis, California, January 10, 1953.

FROM FIELD AND STUDY

Another Hibernating Poor-will.—The first hibernating Poor-will (*Phalaenoptilus nuttallii*) to be found in Arizona was brought to the Arizona Desert Trailside Museum, near Tucson, on January 5, 1953. It was discovered by Alan Blackburn and Lupé Rodriguez as they were collecting an agave in the Silverbell Mountains some 35 miles northwest of Tucson. Rodriguez struck a pick into the ground to loosen the plant and noticed some feathers fly. On investigation, the men found the bird from which they came and which they thought was badly hurt inasmuch as it was dormant. However, there was no mark of injury—only a patch of feathers missing on the neck.

The Poor-will had been sitting under a lower leaf of the agave plant next to the ground. The agave was growing on a gentle north slope at 3000 feet elevation and the bird was on the south side of the plant where the leaves grew close to the sloping earth. Other plants of the hillside were palo verde trees, creosote, hedgehog cactus, barrel cactus and moss. Saguaros grew on neighboring hillsides.

Southern Arizona enjoyed very warm weather during January and February of 1953. The temperature was 73°F. at Tucson on the day that the Poor-will was found, and it was 87° on January 10.

The men placed the Poor-will in the truck cab while they went on with their work of plant collecting for two hours. The warm sun, and perhaps the previous handling, caused the bird to open its eyes and become somewhat active. During the ride home, which took another hour, the bird was covered with a sweater and by the time the Museum was reached it was asleep. It did not waken while being observed by several people nor while having its picture taken in the sun.

For five days the Poor-will was kept in an unheated adobe building. Nights were cool but days quite warm. The bird would be inert or torpid in the morning but it showed signs of wakefulness during the warmth of the day. It was then moved outside the building to a box set half underground. Here it again resumed its dormant state.

On January 25 the Poor-will weighed 34.1 grams. On January 29 a cloacal temperature was taken with a quick-recording thermometer which read 13.2°C. (55.8°F.). The outside temperature was 15°C.

Moths were quite numerous around an outside light during most of January and February and it seems possible that Poor-wills may arouse from their torpid condition and feed in these warm periods. Two Poor-wills were seen in the road in the Tucson Mountains on November 20, 1952, one was seen on February 13, and one on February 26, 1953.

On the morning of January 31 the captive Poor-will was found dead. Cause of death is not known; the bird was not emaciated, nor did examination reveal any injury.—FLORENCE THORBURG, *Tucson, Arizona, March 9, 1953.*

The Brown-crested Flycatcher in the Florida Keys.—On January 1, 1953, at Big Pine Key, Monroe County, Florida, I collected a specimen of *Myiarchus* which evidently was not *Myiarchus crinitus,* for the yellow of its under parts was much too pale for that species. I encountered the bird among the mangroves, about three hundred yards back from the outer shore and at a slightly greater distance from the open pinelands which are so characteristic of much of the island's interior. The flycatcher flew up in response to my "squeaking," alighting well below the tops of the mangroves. Its *pip* or *quip* callnote was not familiar to me. I was not able to determine its sex as the gonads had decomposed by the time I examined the viscera.

Suspecting that I had a new bird for Florida, I compared the skin with a considerable series of the Brown-crested Flycatcher of the race *Myiarchus tyrannulus nelsoni* in my collection from Mexico. Series of *M. t. tyrannulus, M. t. magister,* and *M. t. insularum* were borrowed from the Carnegie Museum through the courtesy of W. E. Clyde Todd. With this material at hand, it was evident that the bird from Big Pine Key was far too large for *M. t. tyrannulus,* not nearly dark-backed enough for *M. t. insularum,* and too small-billed for *M. t. magister*; it was, indeed, *M. t. nelsoni.* The specimen's measurements are: wing, 101 mm.; tail, 95; exposed culmen, 20.5; tarsus, 23. It is, apparently, the first specimen of its species for Florida; and, being a race which breeds in the lower Rio Grande Valley and in parts of eastern Mexico lying just to the south of that area, it is another of the many western birds which have made their way to the peninsula of Florida and the

Florida Keys. The specimen is no. 11543 in my personal collection.—GEORGE MIKSCH SUTTON, *Department of Zoology, University of Oklahoma, Norman, Oklahoma, March 23, 1953.*

Summer Foods of the Burrowing Owl.—An investigation of the food habits of the Burrowing Owl (*Speotyto cunicularia*) in the agricultural region of Mesa Valley, Maricopa County, Arizona, in the summer of 1944 involved the collection and analysis of 405 pellets. The technique for analysis of the pellets followed the procedure described in United States Department of Interior Wildlife Leaflet Number 222 (1942) for food remains of this type. The writer is indebted to Dr. H. H. Knight, of Iowa State College, for his assistance in identification of insect remains.

A total of 48 food items occurred 1,355 times in 405 pellets collected in the months of June, July, and August. The five major food items in order of frequency of occurrence were: scorpions (Scorpionida), 284 (63 per cent); lamellicorn beetles (Scarabidae), 277 (62 per cent); locusts (Locustidae), 250 (55 per cent); ground beetles (Carabidae), 149 (33 per cent); pocket mice and kangaroo rats (Heteromyidae), 101 (22 per cent).

The occurrences of food remains in the pellet samples by months in per cent were as follows: June (245 pellets), Scarabidae, 71, Scorpionida, 70, Locustidae, 60, Carabidae, 44, Heteromyidae, 18; July (104 pellets), Scorpionida, 76, Locustidae, 75, Scarabidae, 71, Carabidae, 34, Heteromyidae, 30; August (56 pellets), Scorpionida, 61, Scarabidae, 54, Heteromyidae, 46, Locustidae, 45, Carabidae, 11.

A comparison of the summer foods by months showed a general similarity in the foods taken. The relative standing of the food types probably reflected the variation in availability. Such food items as scorpions, lamellicorn beetles, and grasshoppers continued to be staple foods throughout the summer.

In an agricultural area such as the Mesa Valley, the beneficial effects of natural insect control, as exercised by the Burrowing Owl, represented an asset rather than a liability to the land owner. As a result it seems logical to assume that the encouragement of the presence of Burrowing Owls, rather than their persecution, should be a part of any wise land use program.—FRED A. GLOVER, *Wildlife Management Department, Humboldt State College, Arcata, California, January 10, 1953.*

Evidence for the Suppression of the American Race of the Pintail.—The American Ornithologists' Union Check-list and many other current reference works continue to divide the Pintail, *Anas acuta*, into two subspecies: *A. a. acuta* Linnaeus of the Old World and *A. a. tzitzihoa* Vieillot of the New World. According to Hellmayr and Conover (Cat. Birds Amer., 1 (2), 1948:357), "the American Pintail is supposed to differ from the European and Asiatic bird by larger size, longer bill and tail, and more greenish speculum." These authors present measurements of 12 adult males from Europe and Asia and of 18 from North America. They concluded that *tzitzihoa* was not separable on the basis of size. They also found the variation in color of the speculum to be unrelated to geographic distribution.

Hørring and Salomonsen (Medd. om Grønland, 131, 1941:8), although having only five American specimens available, were also unable to distinguish *tzitzihoa*. Several other ornithologists have come to the conclusion that *tzitzihoa* is invalid but have not published their findings, and the name continues to appear in much of the current literature.

In his "Key to the Wildfowl of the World" (2nd Ann. Rept. Severn Wildfowl Trust, 1949:pl. 9), Peter Scott considered *tzitzihoa* "very doubtfully distinct." In a later, revised edition (1951) of this key, Scott granted recognition to the American subspecies on the basis of larger size. I have been informed by Mr. Scott that this change was based on inadequate evidence and that he now agrees that *tzitzihoa* cannot be separated from *acuta*.

In order to satisfy my own curiosity as to the taxonomic status of New World Pintails, I measured a somewhat larger series than that available to Hellmayr and Conover. These birds comprised the full-plumaged adult males in the collections of Cornell University, the American Museum of Natural History, and Carnegie Museum, a total of 31 Old World and 23 New World birds. The measurements obtained are shown in the accompanying table. It may readily be seen that although New World birds average slightly greater in tail length, overlap is such that identification of single specimens is impossible. None of the other measurements shows any significant difference. Like Hellmayr and Conover, I was unable to find any consistent difference in the color of the speculum.

Measurements in Millimeters of Adult Males of *Anas acuta*

Wing (flattened)

257–258	259–260	261–262	263–264	265–266	267–268	269–270	271–272	273–274	275–276	277–278	279–280	281–282	283–284	285–286	287–288	289–290
Old World (mean 269.0)																
	2	4	2	3	4	1	6	4	1	1	1			1		
New World (mean 271.9)																
1		1	1	3		5	2	1	4	2	2					1

Tail

149–152	153–156	157–160	161–164	165–168	169–172	173–176	177–180	181–184	185–188	189–192	193–196	197–200	201–204	205–208
Old World (mean 173.9)														
1	1	3	2		4	9	2	2	2	1		1	1	
New World (mean 181.2)														
	1		1		3	2	3	3	2	4			1	1

Culmen

47	47.5	48	48.5	49	49.5	50	50.5	51	51.5	52	52.5	53	53.5	54	54.5	55
Old World (mean 51.7)																
1					2	4	2	4	3	6	1	4				4
New World (mean 51.7)																
		1		2	2		2	2	1	5	3		2	1		2

It thus seems apparent that there are no grounds on which to base continued recognition of the subspecies *tzitzihoa*. The binomial, *Anas acuta* Linnaeus, should therefore be used for all holarctic Pintails unless the proposal of Delacour and Mayr (Wilson Bull., 57, 1945:19) that *Anas eatoni* of the Crozet and Kerguelen islands be considered conspecific with *acuta* receives general acceptance.

Although transoceanic movement of Pintails is probably on too small a scale to affect to any appreciable extent the genetic constitution of either of the major continental populations, it is of interest to recall that such movement is definitely known to take place. A Pintail banded as a juvenile in Iceland was killed at Bradore Bay, Quebec, and another, banded in winter at Los Baños, California, was killed in the spring of the same year at Indian Point, Siberia (Cooke, Bird-Banding, 16, 1945: 125). Two Pintails banded at Hamilton Inlet, Labrador, have been recovered in the British Isles (Cooch, Canadian Field-Nat., 66, 1952:111-112).—Kenneth C. Parkes, *Carnegie Museum, Pittsburgh, Pennsylvania, March 25, 1953.*

Wintering Palm Warbler at Berkeley, California.—On the morning of January 23, 1953, the writer's attention was attracted to a small warbler feeding along leafless branches of a basswood (*Tilia* sp.) on a busy thoroughfare a block from the campus of the University of California at Berkeley. Its conspicuous and constant flitting of the tail plus an oft-repeated *tchep* note indicated that it was a Palm Warbler (*Dendroica palmarum*). In precisely the same row of trees on January 26 the bird was again found, and this time it was observed closely for nearly an hour. Ward C. Russell and I watched the bird at a distance sometimes as close as 15 feet as it actively fed in the trees, in a nearby blackberry tangle atop a garage, and in a flower box of a two-story apartment house. It exhibited a decided preference for the basswood row to which it returned intermittently. On several occasions it made rapid flycatcher-like dashes after flying insects, and on this date it was last seen pursuing an insect over a house top.

On February 2, however, presumably the same bird was noted just across the street from the original site of observation. This time it was somewhat less active than previously, probably due to a heavy fog. It was sitting almost motionless in a hawthorn bush with several English Sparrows. Soon it began to move about in search of food and was collected by Russell.

The bird, a female, weighed 9.3 gms. and had only a little fat. It gave every indication of being in excellent physical condition, and it had a stomach full of insect remains. While preparing the skin we noticed a louse fly (Hippoboscidae) leave the skin. This specimen has been identified as the nominate form, *palmarum*, and is now number 127035 in the collection of the Museum of Vertebrate

Zoology. This represents the second specimen for the state (see Legg, Condor, 55, 1953:162, for additional records).

Attention should be called to two other published accounts of this species in California in the winter of 1952-53 (Legg, *loc. cit.*; The Western Tanager, 19, 1953:28, 42). In both of these occurrences and the present one the birds were observed on more than one occasion indicating that individuals were wintering in their respective localities. In view of the general absence of records in recent years, it would seem that in this past winter there has been a small influx of this species in the state.—DAVID W. JOHNSTON, *Museum of Vertebrate Zoology, Berkeley, California, March 2, 1953.*

The Leconte Sparrow in New Mexico.—On January 25, 1953, I observed some sparrows near Roswell, New Mexico, which I thought to be Leconte Sparrows. On January 26 I returned to the area with James H. Sikes, who concurred tentatively in the identification. On January 28 we took a specimen which has now been compared with an example of Leconte Sparrow (*Passerherbulus caudacutus*) from the collection of the United States National Museum, thereby confirming the identification.

The specimen from New Mexico was taken at a point seven miles southeast of Roswell in Chaves County, one-half mile west of the Pecos River. The habitat here consisted of heavy grass and wild sunflowers along a roadside; an open field with grass and sunflowers extended 200 yards beyond the roadside. The land was marshy, with some water nearby. One hundred or more sparrows of various species were seen in the immediate vicinity, including Savannah, Marsh, Tree, Sage, and White-crowned sparrows. Twenty or thirty Leconte Sparrows were seen; perhaps there were more in the field.

The Leconte Sparrows were shy, flying low when flushed and dropping back into the grass. Sometimes they rested on wire fences, and occasionally they clung to sunflower stalks.

This is the first record of the species in New Mexico. Indeed, we believe there is no record of its occurrence nearer than Utah and central Colorado.—VESTER MONTGOMERY, *Roswell, New Mexico, March 1, 1953.*

Perceptive Powers of a Duck Hawk.—On April 12, 1952, near Barr Lake, northeast of Denver, Colorado, I observed a flock of about eight Baldpates (*Mareca americana*) fly up from a pond in a pasture. Almost at once a Duck Hawk (*Falco peregrinus*) sailed in behind them and struck one to the ground, perhaps 250 yards from my car. When I drove to within approximately 100 yards of where the falcon was beginning to "work" on the duck, the hawk flew up and into a tree across the road so that I was now between it and the duck. After about a minute the duck flew up, apparently laboriously, and passed directly over my head, not more than twenty feet above the ground. As it flew over there was visible a bare patch on either side of the upper part of the neck, undoubtedly where the hawk had begun to pluck the feathers. The duck was able to return to the pond from which the flock had originally been flushed. I turned the car around and started back toward the pond. Before I had got very far, the Duck Hawk left its perch and flew back to the ground where the duck had been. I stopped to see what would happen. After looking around the area for a few moments, the hawk flew toward the car, coming fairly close. It then swerved off and again landed in the tree where it had previously perched. Although it must have seen the wounded duck fly back to the pond, it certainly did not realize it was the duck it had been working on, for it did not fly toward the pond in the period of my observation.—A. SIDNEY HYDE, *Western State College, Gunnison, Colorado, December 18, 1952.*

Bird Records from Northwestern Montana.—Saunders (Pac. Coast Avif. No. 14, 1921:37) lists no records of the Ring-necked Duck (*Aythya collaris*) west of the continental divide in Montana. Hand (Condor, 55, 1953:45) records three non-breeding occurrences in Missoula and Sanders counties, western Montana, in 1941 and 1948. On June 11, 1945, on Island Lake, southeastern Lincoln County, Harry Wilson and I followed and studied a duck and her brood of 7 or 8 downy ducklings. We were often able to maneuver the boat to within 20 feet or less of them.

On June 12, 1945, I located this same duck and her brood and managed to secure close-up photographs of the ducklings (fig. 1). On comparing the prints, the ducklings were readily identified as Ring-necked ducklings. This is, then, the first observation of the breeding of this species in western Montana.

Fig. 1. Downy young of Ring-necked Duck in marsh growth at shore of Island Lake, Lincoln County, Montana. Photograph by John L. Blackford.

Saunders (*op. cit.*: 147-148) described the Black-poll Warbler (*Dendroica striata*) as a migrant in eastern Montana, found only in the prairie region of the state, and so far reported only in spring. However, in citing migration records from Great Falls and Choteau, it is clear that he refers to Montana east of the divide, thus leaving only the western third of the state without records of occurrence. The breeding range of the species has been known to extend south to central interior British Columbia (specimens in Mus. Vert. Zool.).

On July 6, 1941, after several days of intermittent pursuit of a new songster, I finally identified a male Black-poll Warbler near my former home two miles north of Libby, Montana. On July 8, 11, 19, and 30 it was recorded as singing steadily or frequently. On August 10, 1941, I recorded it as singing occasionally.

The dates of these observations from July 6 to August 10, the presence of the singer for a week previous, and the behavior indicated that the species was probably breeding here that year. The area directly concerned in these warbler observations was at the foot of a hill in understory of birch, mountain maple, and young spruce beneath primal Douglas fir-western larch-yellow pine overstory. Occasional large spruces (white or Engelmann) were scattered through the area. The elevation was 1980 to 2020 feet.—JOHN L. BLACKFORD, *Libby, Montana, February 5, 1953.*

Forster Terns Breeding on San Francisco Bay, California.—In central California the Forster Tern (*Sterna forsteri*) has long been known as a nesting species at Elkhorn Slough near Moss Landing, northern Monterey County, and at Los Baños, Merced County. Grinnell and Miller (Pac. Coast Avif. No. 27, 1944:174-5) knew of no breeding records for the San Francisco Bay region where the status of the species was considered by them to be that of a migrant and winter visitant. It seems likely, therefore, that the three breeding colonies which are here noted are of recent establishment.

On May 28, 1948, in company with the late Henry W. Carriger, Milton L. Seibert visited a colony containing an estimated 100 nests near the eastern approach to the San Mateo Bridge in Alameda County. This colony was first discovered by Mr. Carriger in 1947 or 1948. On May 6, 1951, near the eastern end of the Dumbarton Bridge in Alameda County, the writer noted adult Forster Terns carrying fish while in flight and saw adults apparently sitting on nests on a partly submerged dike in an evaporation pond of the Leslie Salt Company.

On July 8, 1952, Mr. Seibert and I visited two of the localities mentioned. The colony at the end of the Dumbarton Bridge was located on an old salt pond dike, now disconnected from other land areas so as to provide the birds with three low, narrow islands. The emergent surface was approximately four feet wide and 300 to 400 feet in length. This locality is approximately one-half mile southwest of the transmitter building of radio station KGO and on the opposite side of the highway from the station. The following census was made: adult birds in the vicinity, 60 to 70; juveniles on the wing, 10 to 15; juveniles out of the nest but not yet flying, 30 to 35; downy young in or near nests, 3; dead young birds on the dike, 25; nests containing one egg, 7; nests with two eggs, 4; nests with three eggs, 2; eggs out of nests, scattered on the ground, 45. An Avocet (*Recurvirostra americana*) nest containing one egg was on the dike with the tern nests.

The colony at the east end of the San Mateo Bridge was located on the property of the Oliver Brothers Salt Company, approximately one mile south of the highway approach to the bridge. The nests were widely dispersed on salt pond dikes and a complete census was impossible. On one of the dikes, approximately one-half mile in length, the following count was obtained: downy young, 3; nests containing one egg, 8; nests with two eggs, 7; nests with three eggs, 10; nests with four eggs, 1; eggs out of nests, scattered on the ground, 35. More than 50 fledged juveniles were observed in the vicinity and the total number of adults was estimated at between one and two hundred.

On June 7, 1953, in company with Dr. Eric Reynolds, Mr. Vaughan MacCaughey, and Mr. Alexander Sprunt IV, a third colony was found on Leslie Salt Company property, six-tenths of a mile south-southwest of Plummer's Landing and approximately two miles southwest of Newark, Alameda County. This colony was situated on a low dike covered with dry, dead *Salicornia*. The plants had been killed by the constant high level of water which has been maintained for that purpose by recent diking off of the tidal drainage channels. Eleven nests were found in a linear distance of 245 feet, 10 of them being in a space of 160 feet along the dike. Seven of the nests contained three eggs each and one nest contained two eggs. The other three nests were empty but within four feet of each of two of them were pairs of downy young approximately two days old. No remains of nests from previous years were detected. It seems probable that this colony was established only this year.

It is apparent that the presence of these colonies is dependent on the combination of factors resulting from the activities of the salt companies. The low dikes and the constant water level maintained in the evaporation ponds seem to be the factors which permit the establishment and success of the tern colonies. The colony at Elkhorn Slough, Monterey County, is also located on the dikes separating the evaporation ponds of a salt company. On May 24, 1952, this colony was estimated to contain close to 500 adults and 158 nests containing eggs were counted on dikes which represented approximately one-half of the nesting area. One nest contained newly hatched young on this date. On June 28, 1952, the colony contained nests with eggs and young in all stages of development, from hatchlings to fledged juveniles.

On several occasions in late spring and summer Forster Terns have been observed carrying fish in their bills in the vicinity of the Leslie Salt Company's evaporation ponds west of Alviso, Santa Clara County. It seems likely that a breeding colony may be located in that area.—CHARLES G. SIBLEY, *Department of Conservation, Cornell University, Ithaca, New York, September 24, 1952.*

Additional Records for the American Redstart in the Imperial Valley of California.—In the spring and fall of 1952, we recorded the American Redstart (*Setophaga ruticilla*) on three different occasions. We collected an adult female 3 miles southwest of Niland, Imperial County, on May 15, 1952. On the next day we collected an adult female near the east edge of the Salton Sea west of Niland. Both redstarts were found flitting about in tamarisk trees with Orange-crowned and Pileolated warblers. On September 13, 1952, we collected an adult male 10 miles north of Westmorland, Imperial County. It was first observed in a thicket of screw-bean mesquite (*Prosopis pubescens*) with other warblers.

There is one other record for the American Redstart in the Imperial Valley—a female collected by us on October 3, 1948, near the southeast edge of the Salton Sea (Condor, 51, 1949:44). All four specimens are in the Cardiff Collection.—EUGENE CARDIFF *and* BRUCE CARDIFF, *Bloomington, California, March 31, 1953.*

NOTES AND NEWS

The Cooper Ornithological Society is developing plans for holding its annual meeting of 1954 at Tucson, Arizona. The ornithologists of the Tucson area through Allan R. Phillips and Joe T. Marshall, Jr. have extended an invitation for April 22–24. Later, official announcement from the Board of Directors will be made, with designation of the local committee in charge of the meeting. Such a meeting should prove most attractive to members of the Society, as the rich desert avifauna is at the height of its activity in April. Also the organization is anxious to meet at this important ornithological center.—A.H.M.

PUBLICATIONS REVIEWED

Birds of Mexico, A Guide for Field Identification. By Emmet Reid Blake, illustrated by Douglas E. Tibbitts. University of Chicago Press, xxx+644 pp., many figs. (unnumbered), colored frontispiece. 1953. $6.00.

This is the first true field guide to the birds of México and as such is of distinct importance and usefulness at this juncture in the development of the ornithology of that country. México has a large avifauna which includes approximately 1000 species, 750 of which are resident. Moreover it includes a large proportion of tropical species and therefore this guide will prove to be of much service in adjacent Central America.

The descriptions and keys properly are for species, not subspecies, and they emphasize, rather well in the main, the conspicuous features likely to be detected in the field. Such information as can be added on habitat and song aid further in field identifications.

Vernacular English names are developed for species, and we are thankful to note that they are omitted entirely for subspecies. The species names largely reflect the endeavors of Eugene Eisenmann who has sought to build up a logical and accurate set of names for Central American birds. Much as we are in sympathy with this effort, we see no reason for Blake and Eisenmann to view with such complete disfavor certain patronymics and geographic designations. For example, the Sclater or Mexican Chickadee has long borne the latter name. No confusion would result from either of these names. The species is essentially Mexican in distribution and is more typically Mexican than any other chickadee or titmouse. What is to be gained, then, by calling it Gray-sided Chickadee, a not inappropriate name, but an innovation that is hardly necessary?

About one-third of the species are illustrated with black and white sketches. Many of these adequately serve the purpose of aiding in identification, but there are many that are poor. Obviously the artist has worked under the handicap of not having had a chance to see the species in the field. For example, Californians will be especially disturbed by the appearance of the Wrentit; the bill of the White-breasted Nuthatch seems to be only about half as long as it should be; the Saw-whet Owl apparently is a Pigmy Owl (*Glaucidium gnoma*), judging from tail position (correctly described in the text), tail barring, flank markings, and spotting of the crown.

With respect to the genus *Junco*, the reviewer hesitates to register an objection since Blake should certainly be free to voice his own opinions in dealing with this complicated group. We recognize room for differences of opinion on the question of whether the partial reproductive isolation of *J. hyemalis* and *J. oreganus* is enough to call for a species separation; a related doubt may be entertained about *J. oreganus* and *J. caniceps*. But Blake does some queer reassorting, perhaps influenced by Hellmayr's much earlier (1938) and admittedly tentative treatment. Thus the Mexican Junco (*J. phaeonotus*) is termed the Yellow-eyed Junco but included in it is the brown-eyed form *dorsalis* which has been shown to be racially related to *caniceps* and not to *phaeonotus*—facts that have not been challenged so far as I am aware. At the same time, *bairdi*, the yellow-eyed form of the Cape district of Baja California is placed in the brown-eyed species *J. oreganus*, thus quite obscuring its affinities with the forms of the central Mexican highlands and Chiapas. Incongruous with his mergers is his maintenance of *hyemalis* and *oreganus* as separate species. A field guide and the review of it are not, however, the places for a new revision of the genus *Junco*.

Even though one does find errors, some technical aspects to challenge, and obvious lacks in information, the general value of Blake's book is not impaired and it serves its chief purpose well. Indeed as a pioneer venture in comprehensive guidance to the Mexican avifauna it is greatly to be admired. Blake can not be held accountable for the marked imperfection that persists in our aggregate knowledge of the birds of this fascinating country.—Alden H. Miller.

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For Sale—Mammals and Life Zones of Oregon, Bailey, $6.25; Avifauna of Galapagos Islands, Swarth, $3.25; Biological Investigations in Mexico, Goldman, $3.50; Game Birds in Hawaii, Schwartz, $3.50.—H. H. T. Jackson, *U. S. National Museum, Washington 25, D. C.*

For Sale—Ornithology of California, Cooper, $6.50 (newly bound); Manual of North American Birds, Ridgway, $5.00 (newly bound); Birds of the Colorado Valley, Coues, $4.50 (newly bound); Game Birds, Wild Fowl and Shore Birds, Forbush, $2.50; Birds of Virginia, Bailey, $2.00; A. O. U. Checklist—1910, $2.00; Michigan Bird Life, Barrow, $3.50; Mammals of Connecticut, Goodwin, $2.00; Bent's, 107, Diving Birds, $25.00 (orig. ed.), 121, Petrels and allies, $9.00, 130, Wild Fowl, $7.50, 146, Shore Birds, $4.50; Birds of California, Wheelock, $1.00 (worn); Frick Expedition to Ethiopia and Kenya Colony, Friedmann, $3.00; East African Mammals, parts 1 and 3, Hollister, $4.00; Mammals of the Mexican Boundary, Mearns, $1.00; Monograph of *Chordeiles*, Oberholser, $1.00; Mammals of the Adirondacks, Merriam, $6.00 (autographed copy); North American Land Mammals—1911, Miller, $2.00; Bird Life of Urubamba Valley, Peru, Chapman, $1.00; American Bats of the Genera *Myotis* and *Pizonyx*, Miller and Allen, $2.00; Families and Genera of Bats, Miller, $2.50; Catalogue of Type Specimens of Mammals in the National Museum, Lyon and Osgood, $1.00; Natural History of Cetaceans, True, $4.00; Ground Squirrels of California, Grinnell and Dixon, $1.00; Avifauna of the Galapagos Islands, Swarth, $3.00; Journal of Mammalogy, vols. 1-17, $90.00; postage extra on all items.—Laurence M. Huey, *Natural History Museum, Balboa Park, San Diego, Calif.*

For Sale—Richdale's four monographs on life histories of albatrosses and penguins available at cost.—Dean Amadon, *American Museum of Natural History, New York 24, N. Y.*

Wanted—To purchase at reasonable prices: Casey Wood's Guide to the Literature of Vertebrate Zoology, and Max Meisel's Bibliography of American Natural History. Any information as to where these publications can be purchased will be appreciated.—James Hodges, *St. Ambrose College, Davenport, Iowa.*

Wanted—Experienced field collector desires contact with ornithologists, mammalogists, and museums interested in procuring scientific study skins of birds and mammals from oriental regions, such as Formosa, Thailand, Burma, Ryukyu Islands, etc.; expect only a few reasonable expenses in return for specimens.—Masayuki Ono, *YMCA Dormitory, 19 Hsu Chang St., Taipei, Taiwan (Formosa), China.*

PREPARATION OF MANUSCRIPTS FOR THE CONDOR

Articles published in the Condor normally are written by members of the Cooper Ornithological Society. Practically all the Society's money goes into the journal; no editor or business manager receives any pay other than the satisfaction of doing a service worthily. The preparation of good copy by the author will contribute greatly to accuracy of published output, dispatch in handling, and economy of production.

To be acceptable for inclusion in the Condor, articles must not duplicate in any substantial way material that is published elsewhere. Any type of subject bearing on birds may be considered; but the geographic areas of primary concern are western North America, Central America, and the Pacific Basin. Manuscripts may be sent to the editors at the Museum of Vertebrate Zoology. Proofs with edited manuscripts will be sent to authors, at which time reprints may be ordered.

In the interests of accuracy and economy, observe the following: do not duplicate data in text, tables, or charts; check citations to original sources and verify text references; quoted statements must be exact replicas of the original; preferably use vernacular names applicable to the entire avian species (for a guide in this regard, see "The Distribution of the Birds of California," Pac. Coast Avif. No. 27, 1944:5-34); in general, avoid subspecific vernaculars; insert scientific names for species but not the subspecific name except in taxonomic papers or where the race concerned has been critically determined by the author or his collaborators; revise the manuscript repeatedly to remove superfluous words and phrases, immaterial detail, and repetitious statements.

Note Condor style and usage. "General Articles" and the "Field and Study" items are set up in different form. Provide a concise, meaningful title, and, where needed, subtitles within the text. Footnotes are not used. The address line may serve to indicate institutional connection, and to it should be added the date of transmittal of the manuscript. Terminal bibliographies are desirable where five or more titles are to be cited; otherwise, the references may be included in the text. For bibliographic style, note closely the practices employed in recent volumes of the journal. A factual summary is recommended for longer papers.

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